

[Issued with Army Orders for December, 1921.]

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HANDBOOK
OF THE
Q.F. 18-PR. GUNS,
MARKS I, I*, II AND II*,
ON
CARRIAGE, FIELD,
MARK I.

LAND SERVICE.

1921.



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N.B.—This book is corrected up to October, 1921. Any alterations which may be suggested should be forwarded direct to the Chief Inspector, Royal Arsenal, Woolwich.

PART I.

INTRODUCTION.

The *Mark I* Q.F. 18-pr. equipment was introduced into the Service in June, 1904, and was designed to embody the experiences of the South African War.

The design embodied many new features, prominent amongst which the following may be cited :—

- Single loading.
- Long recoil.
- Independent line of sight.
- Top traverse.

In addition the carriage and ammunition wagon, together with their limbers, are provided with shield protection for the detachment in action. These features, coupled with improvements in design and developments in materials, allowed of the provision of a more powerful equipment than had hitherto been possible within the limits of weight usually considered satisfactory for Field Artillery.

Single loading is obtained by means of a fixed Q.F. cartridge, comprising means of ignition, propelling charge, projectile and fuze in one unit, thus ensuring smooth and rapid loading. The long recoil buffer gives reduced firing stresses on the carriage and increases its steadiness in action. The independent line of sight and top traverse enables the layer to carry on his duties without hindrance by the loading or ranging functions, thus resulting in a greater accuracy and rapidity in the service of the gun. The shield is of great value as it affords the detachment a sense of security, which, combined with the above-mentioned new factors, has resulted in the provision of what has proved to be a highly satisfactory equipment.

A further point of interest is the provision of seating accommodation on the trail for the laying and breech numbers, an advantage rendered possible by the steadiness of the carriage during recoil.

The limbers and ammunition wagon were improved with the object of facilitating the ammunition supply in action. The ammunition is carried practically ready for loading, only needing the removal of safety clips and setting of time fuzes. The latter are of the tension type, and do not require unclamping before setting, or clamping after setting. When in the limbers and wagon, only the base of the case of the cartridge is visible, consequently it has been found necessary to have identification marks on the base of the cartridge, in addition to those on the shell, to avoid confusion and delay when several natures of projectile are carried in the same vehicle.

Originally, the only projectiles provided were shrapnel, with a small number of star shell for special purposes ; at present, however, shrapnel, high explosive, gas, and smoke are all provided. Incendiary ammunition has also been in use until recently.

On the whole, the equipment may claim the following advantages over field equipments of earlier designs :—

- Heavier and more powerful projectile.
 - Increased rate and accuracy of fire.
 - Better protection for gun detachment.
-

PART II.

ORDNANCE.

Q.F. 18-PR., MARKS I, I*, II AND II* GUNS.

PARTICULARS.

Material	Steel (wire construction).
Weight (with breech fittings) ..	9-cwt.
Length, total	96·96-inches.
Bore { calibre	3·3-inches.
{ length (to face of breech screw) ..	92·62-inches.
Rifling { system	Polygroove, modified plain section.
{ length	80·232-inches.
{ twist	Uniform, 1-turn in 30-calibres.
{ grooves { number ..	18.
{ depth ..	0·04-inch.
{ width ..	0·384-inch.
Firing mechanism	Percussion.
Position of centre of gravity (without breech mechanism)	35·7-inches from face of breech.

GUN BODY, MARK I.

(Plate I.)

The gun is made of steel and consists of the "A" tube, a series of layers of steel wire, jacket and breech ring. The "A" tube extends from the rear end of the chamber to the muzzle. Over the rear portion of the "A" tube are wound successive layers of steel wire. The jacket is fitted over the exterior of the wire and "A" tube and is secured longitudinally by corresponding shoulders and the breech ring, which is screwed over the jacket at the rear and secured by a set screw. The breech ring is prepared for the reception of the breech mechanism and is provided on the upper side with a lug for the attachment of the hydraulic buffer. Longitudinal projections on each side of the jacket form guides for the gun when in the cradle of the carriage.

The chamber is slightly coned throughout its length, to facilitate the extraction of the cartridge.

A plane for clinometer is prepared on the upper surface of the breech ring.

An axis line is cut on the right side of the breech ring. Vertical and horizontal lines are also cut on the muzzle face and horizontal lines on the breech face.

The guns are marked on the top and right side with black and red lines on white ground for indicating excessive recoil. The black and red lines are each 0.5-inch wide, the red being nearest the muzzle and 47 inches from the front of breech ring.

GUN BODY, MARK I*.

*Mark I** guns are *Mark I* guns repaired by the renewal of the "A" tube.

The repair consists in fitting into the old jacket, under hydraulic pressure, a new "A" tube with new winding wire. The exterior of the "A" tube with its wire is slightly tapered and the interior of the jacket is bored to correspond.

GUN BODY, MARK II.

(Plate I.)

Mark II guns differ from *Mark I* as follows:—

The exterior of the "A" tube is slightly conical, the interior of the jacket being coned in a corresponding manner to admit of the guns being built up by means of hydraulic pressure instead of by shrinkage.

NOTE.—A certain number of *Mark II* guns have been fitted with a "catch retaining cartridge" for use against aircraft. These guns are now obsolete as far as anti-aircraft requirements are concerned, and have been converted for use on field carriages by having the cartridge retaining catch plunger and spring removed, and the outer end of the hole for catch in the breech ring filled by the cartridge retaining catch plug. The plug is secured from turning when in position by having the metal of the breech ring riveted into chisel nicks and the outer end is rounded to the contour of the breech ring.

These guns are distinguished by having a star (*) added to the Mark and are described as *Mark II**.

BREECH MECHANISM.

(Plate II.)

The guns are fitted with "Single Motion Breech Mechanism." The mechanism is so arranged that by one pull on a lever the breech is unlocked and the screw and carrier are swung into the loading position. After loading, one thrust on the same lever inserts the breech screw into the breech opening and turns it into the locked position.

BREECH CLOSING MECHANISM.

The breech is closed by a steel screw tapering towards the rear (Maelstrom type). Segments of the screw thread are removed from opposite sides of the screw; the breech opening of the gun being prepared in a corresponding manner, admits of the screw being locked in the gun by the fourth of a turn.

The screw is provided on the rear-end with left-hand screw threads which engage with corresponding screw threads in the inner face of the carrier.

The carrier for supporting the breech screw when withdrawn from the gun, consists of a steel arm hinged to the right side of the gun at the breech. It is prepared on the inner face for the reception of the breech screw and on the outer face with a recess for the striker guide block and two lugs for the hinge bolt of the breech mechanism lever. A steel catch with spiral spring is fitted to the interior of the carrier and serves to retain the breech screw in the open position. The catch is automatically released in closing the breech.

In order to prevent damage to the breech mechanism, in the event of a failure of cartridge case, a gas escape hole and channels are formed in the carrier.

Hinged to the rear face of the carrier is a breech mechanism lever provided with bevel teeth which engage with corresponding teeth on the rear face of the breech screw, so arranged that when the lever is pulled to the right, the first movement of the lever unlocks the breech screw, and on continuing the motion the screw and carrier are swung into the loading position.

The breech mechanism lever is retained in the closed position by means of a catch (with flat spring in the case of *Mark I* lever or spiral spring in the case of *Mark II* lever) pivoted in the lever, one end of which engages a recess in the lower lug on the rear face of the carrier.

FIRING MECHANISM.

(*Plate III.*)

The firing mechanism is for percussion firing and is so arranged that the gun cannot be fired before the breech screw is locked and the breech mechanism lever home.

It consists of a striker with firing pin, rebound block and securing pin, main spring, guide for spring and tripping piece with flat spring and fixing screw, fitted through the centre of the breech screw and retained in position by the striker guide block on the carrier. A steel firing lever in the interior of the striker guide block serves to cock the striker and fire the gun, one end of the lever engaging with the tripping piece and guide for spring, the other end with the trigger in the left side of the gun when the breech is closed.

The trigger is actuated by a direct pull on the firing gear of the carriage, thus partially revolving the firing lever, by means of which the striker is forced to the rear and the guide for spring to the front; the main spring is thus compressed until the projecting toe on the inner end of the firing lever slips past the front-end of the tripping piece in the striker guide block, when the striker is free to go forward with momentum due to the energy stored up in the compressed main spring and detonates the percussion primer of the cartridge.

The firing lever is returned to the firing position by means of the guide for spring.

The front-end of the firing pin in the striker is withdrawn within

the firing hole bush by means of a rebound block in the striker, which engages a recess in the breech screw for its reception.

A loop is provided on the lower part of the trigger for the attachment of a firing lanyard if required.

A safety catch, with flat spring, is fitted to the striker guide block for retaining the striker in the uncocked position, thus admitting of the gun being travelled with a cartridge in the bore.

NOTE.—The hook of the firing lanyard is of special pattern and must be attached to the loop on the trigger as shown on Plate XXI. Should a jam occur after firing, care must be taken to see that the striker is flush with the rear-end of the striker guide block before force is used to open the breech. In cases where the striker is not flush with the guide block, withdraw the keep pin and hinge bolt of the breech mechanism lever and remove the lever, guide block, firing lever and striker from the gun. Replace the breech mechanism lever and hinge bolt and swing the breech screw and carrier into the loading position. Replace the striker, firing lever and guide block.

EXTRACTOR.

The extractor is of steel and is hinged to the right side of the gun. On the inner end are two arms which clip the rim of the cartridge, the outer end forming a lug, by means of which the extractor is automatically actuated in opening the breech.

INSTRUCTIONS FOR REMOVING AND REPLACING BREECH FITTINGS.

TO REMOVE THE BREECH FITTINGS.

Before commencing to remove the fittings, the breech screw and carrier should be swung into the loading position.

Breech mechanism lever, guide block, firing lever, striker and firing pin.—Remove the keep pin of the breech mechanism lever hinge bolt and withdraw the hinge bolt, when the breech mechanism lever, guide block with firing lever and striker can be removed. Slide the firing pin out of the striker.

Breech screw and retaining catch.—Press in the catch retaining breech screw clear of the recess in the screw and unscrew the latter (to the right) from the carrier. Withdraw the retaining catch with spiral spring.

Firing hole bushes, Marks I and II. (This will only be carried out by an armament artificer.)—Unscrew the bush from the interior of the breech screw by means of the special wrench. In the case of *Mark II* bushes, care must be taken to first remove the fixing screw for the bush in the breech screw.

Carrier.—Remove the keep pin of the carrier hinge bolt and withdraw the hinge bolt and carrier.

Extractor.—Remove the keep pin of the extractor hinge bolt and withdraw the hinge bolt and extractor.

Trigger.—Remove the keep pin and withdraw "Part I" trigger

with bush, collar and spring from the left side and "Part II" trigger to the rear.

Striker and guide block.—When removing the striker from, or inserting it into, the guide block, the safety catch in the latter must always be in the firing position.

Striker, main spring, &c.—Press on the top of the spring guide so as to slightly compress the main spring and at the same time tilt the upper end of the guide from the striker and withdraw the guide and main spring. Slide the firing pin out of the groove in the front-end of the striker. Remove the pin securing rebound block and withdraw the latter.

Safety catch, guide block.—Place the safety catch in the firing position and force it out of its recess in the guide block towards the centre of the block and withdraw it.

TO REPLACE THE BREECH FITTINGS.

The fittings are replaced in the reverse order.

When inserting the breech screw in the carrier, care must be taken, before commencing to screw in, to hold the breech screw "square" against the face of the carrier with one of the threaded portions of the screw uppermost, the stamping on the screw being to the rear. Two and one-quarter turns of the breech screw are required in screwing in, the retaining catch being pressed in clear of the recess in the screw during this operation.

When inserting the trigger, first correctly assemble the spring with the projecting ends in the holes for their reception in the "Part I" trigger and bush, then insert the collar on the trigger with the recessed portion innermost and twist the bush on the trigger until the projection on it engages with the recess in the collar. Insert "Part I" trigger with bush, collar and spring into the left side of the gun and engage with "Part II" trigger inserted from the rear. Insert keep pin.

TO GAUGE PROTRUSION OF FIRING PINS.

The protrusion of firing pins of strikers is gauged by the "Gauge, striker protrusion, No. 1." The instructions for use of gauge are as follows :—

Swing the breech screw and carrier into the loading position and remove the striker. Take out the main spring from the striker and re-assemble the latter. Replace the striker (without main spring) in position in the breech mechanism, press in the "Catch, retaining breech screw" and revolve the breech screw in the carrier until it is in the position it would be for firing if the breech were closed.

Press the striker forward in the breech screw as far as it will go and apply the gauge to the front face of the breech screw.

If the protrusion of the firing pin is not between the limits of .009-inch to .011-inch, as shown by the gauge, the firing pin will be exchanged.

PART III.

CARRIAGE, SIGHTING, LIMBERS AND AMMUNITION WAGONS, &c.

CARRIAGE, FIELD, Q.F. 18-PR., MARK I.

(*Plates IV and V.*)

The carriage is constructed to allow of 16-degrees elevation and 5-degrees depression being given to the gun, which recoils axially in a cradle, the latter being fitted with a hydraulic buffer to limit the recoil and running-out springs to return the gun to the firing position. The carriage is also constructed so that the elevation of the gun can be altered without interfering with the line of sight. It is provided with a seat on each side of the trail for two of the gun detachment and with a shield for the protection of the numbers serving the gun.

The carriage is fitted to carry various stores (*see list of stores, p. 31, and packing diagram, page 35*).

The principal parts of the carriage are :—

Trail (A).	Traversing gear (F).
Carriage body (B).	Firing gear (G).
Cradle (C).	Brake gear (H).
Hydraulic buffer.	Shield (J).
Running-out springs	Axletree and wheels (K).
Elevating gear (D).	Sight (L).
Range gear (E).	

TRAIL.

The trail is tubular and is secured to the axletree by a bracket, which also forms a pivot for the carriage body. The rear end is fitted with a spade, lifting handles, trail eye and a traversing lever, the latter folded down and held by a spring clip when not in use. Near its lower end is shrunk on a locking band; about its centre is a band for the attachment of the brake arms and rear-ends of tensile stays and in front of this again is a bracket with a dovetailed projection on which the rear-end of the carriage body slides for purposes of traverse. A handhole and a cover is provided on the upper side for the attachment of the traversing lever bracket on repair.

Clips are attached to left-hand side of trail for the purpose of carrying "Case, Memorandum of Examination."

CARRIAGE BODY.

The body consists principally of two triangular-shaped brackets connected by transoms and provided with bearings on the underside at the front, through which the axletree passes and by which it is pivoted for traversing. To the underside at the rear is fitted a bracket in which is formed a groove to fit over the traversing bracket on the trail. Bearings are fitted on the top front to receive the cradle trunnions which are held in position by capsquares.

An arc, which is used in conjunction with a clamp on the trail and body to lock the body to the trail in travelling, is fitted on the right side ; it allows of adjustment of the clamp as required.

CRADLE.

The cradle is of bronze, with steel trunnions to pivot it to the carriage body, the left trunnion being prolonged and threaded for the reception of a stud for supporting the rocking-bar sight ; it has an opening in the lower portion for the gun and in the upper portion for the spring case. Longitudinal recesses are cut in the inner surface of the lower portion for the reception of the guides on the jacket of the gun. A steel guard is fitted to the left side to protect the gunlayer, and a notch and point are formed above the spring case for rough laying.

CRADLE CLAMPING GEAR.

(*Plates VI and VII.*)

The gear is provided to clamp the cradle to the carriage body in the travelling position. A spindle with clutches and handle is fixed to the carriage body, so that when the gun is fully elevated the clutches may be made to engage with semicircular-shaped lugs formed on the underside of the cradle and rigidly fix the cradle to the carriage. Two stops, one of which is adjustable, are fitted to the carriage body to limit the travel of the handle of the clutch spindle. This gear also determines the point of maximum elevation. In the event of the clamping gear becoming jammed and difficult to release, it can be overcome by easing the *lower* elevating wheel by hand before unclamping.

HYDRAULIC BUFFER AND RUNNING-OUT SPRINGS.

(*Plate VIII.*)

The hydraulic buffer, which is contained in the spring case in the upper portion of the cradle, consists of a cylinder, piston with rod, control plunger and stuffing-box with gland. The cylinder is closed at the rear by the control plunger and at the front by the stuffing-box and gland, which are locked in the required position by a spring stud. The cylinder is attached to the gun and secured by two nuts. A number of longitudinal grooves are formed on its inner surface, the depths of which are graduated so that the space for the flow of the liquid between the piston and the cylinder varies during recoil ; by this means a graduated pressure is maintained in the buffer throughout the stroke. The front-end of the piston rod is fixed to the front of the spring case. The rear-end is bored for the reception of the control plunger, which, by displacing the liquid inside the piston rod, brings the gun gently to rest when returning to the firing position.

The piston (*Mark IV*) has a bush which is thickened up towards the flange end and formed with a radius. It is provided with a detachable

piston ring and collar securing ring. The piston ring is made of bronze, fitted against the shoulder on the body and is secured in position by a steel securing collar, with two set screws. When assembled the piston ring is free to rotate on the body.

A filling hole closed by a plug with chain is provided near the top rear-end of the cylinder.

The running-out springs surround the hydraulic buffer cylinder and are enclosed in a steel case which is screwed into the cradle above the gun. They consist of two sets, inner and outer, which are held under initial compression between an external flange on the front-end of the buffer cylinder and an internal flange at the rear-end of the outer spring case; each set is divided into four sections, separated by parting plates; the inner and outer sets are also separated longitudinally by an inner case.

For the better detection of a leak in the gland, holes are bored in the spring cases; four holes near the rear-end of the inner spring case and two holes underneath, one at the front and one at the rear of the outer spring case.

To ensure the buffer being kept full of oil the outer spring case at the front-end is fitted with a cap having a tank (**not shown on Plate VIII**). The tank contains a perforated vertical pipe with valve which is in direct communication with the interior of the buffer through the hollow piston rod; a small hole through the valve throttles the liquid and thus assists in controlling the run-out.

The top of the tank is closed by a screwed plug having a central hole for filling purposes in which a valve is fitted to prevent any exit of oil from the tank as the gun returns to the firing position.

A cover is hinged to the top of the cap which gives access to the gland for tightening up, and also to the air valve of the buffer cylinder.

A steel shield for protecting the tank is fitted and held in position by two studs.

The capacity of the buffer is $4\frac{1}{2}$ -pints.

The capacity of the buffer and tank is $6\frac{1}{2}$ -pints.

Action.—When the gun recoils on firing it draws the buffer cylinder with it to the rear; the liquid in the cylinder in passing from front to rear of piston is forced through the grooves in the cylinder, which sets up a hydraulic resistance, so absorbing the energy of recoil and bringing the gun to rest. The shape of the grooves is such that the flow space gradually diminishes and by this means the pressure is graduated. Meanwhile the running-out springs have been further compressed; their subsequent expansion causes the gun to return to the firing position, and in doing so the control plunger displaces the liquid in the rear-end of the piston rod, the liquid escaping over the tapered flats, which results in the gun being gently brought to rest in the firing position. The working recoil is about 41-inches, metal to metal 49-inches.

For filling of buffer, replacement of springs, &c., see pages 41 to 45.

ELEVATING AND RANGE GEAR.

(Plates VI and VIA.)

The elevating gear is divided into two portions, upper and lower, by the employment of a double-ended elevating screw to the centre of which an arm carrying the sights is attached.

The gears are so arranged that the elevation of the gun can be altered without altering the line of sight. The handwheel on the left of the carriage is for aligning the sight on the target (the range indicator remaining stationary), while the handwheel on the right side is actuated until the required range is indicated on the yard scale ring (the sight remaining stationary).

The *Mark III* range gear indicator (Plate VIA) consists of a spring case with woodite washers, stud, clock type spring, spring barrel, jamming plate, yard scale ring, pointer degree scale with two screws, M.V. scale plate, plate carrying M.V. scale, two readers (one for yard scale and one for M.V. scale), carrier M.V., pointer and reader.

It is fitted to the right side close to the handwheel, the yard scale ring being graduated on its face in hundreds of yards to 6,600-yards with readings for every 25-yards; the periphery of the ring is graduated up to 16-degrees with readings for every 10 minutes; the yard and degree scale is prevented from slipping by two woodite washers; the washer on the inside bears between the ring and the spring case and that on the outside between the ring and the jamming plate. The gear is supported on a cross spindle which is held in bearings in the cradle. The inner end of the spindle carries a pinion which works in the arc supported from the centre of the elevating screw. The spring case contains a clock spring which eliminates backlash between arc and pinion.

A M.V. carrier is secured to the handwheel spindle pinion bearing, the M.V. scale carrying plate with a graduated M.V. scale being attached to the carrier and the indicator pinion.

A catch and plate is fitted to clamp the range gear.

A bracket for No. 7 dial sight, with carrier and deflection scale, is secured by screws to the arc of the range gear. A clamping screw is provided for securing the carrier in the bracket.

On coming into action (gun being in the housed position) release the clamping handles of the cradle and carriage body clamping gears, place the traversing pointer at 0-degree and bring the gun to about the horizontal position by means of the left elevating handwheel. Either gear, elevating or range, can then be worked as required.

TRAVERSING GEAR.

(Plate VII.)

The traversing gear consists principally of a crosshead, link nut and an actuating screw with a handwheel. The crosshead is pivoted vertically to the traversing bracket on which the rear end of the carriage body slides. The working parts are protected from the ingress of dust, &c., by cotton packing, packed round the outside

of the link nut. The nut is linked to the carriage body, and by means of the handwheel on the end of the screw, 4-degrees of traverse right or left can be obtained. A scale strip and pointer indicate the angle of traverse. The scale strip has black graduations on brass on the left and white graduations on a black ground on the right side of zero. A leather loop, fixed to the cap of the lower elevating gear bracket, is slipped over the handle of the handwheel to prevent the latter turning when travelling.

FIRING GEAR.

The firing gear is arranged so that the layer can fire the gun without altering his position when laying. It is attached to the left side of the cradle and consists principally of a connecting rod, connecting arm and a spring lever, which engages with the trigger of the gun. The connecting arm is pivoted to a fulcrum on the cradle at one end; the other end is connected to a spring lever by the connecting rod, which is provided with a handle for operating the gear. After firing, the handle is returned to the forward position by a spring attached to the lever and the guard protecting gunlayer.

The gun can be fired when within 2-inches of the "run-up" position.

BRAKE GEAR.

(Plate IX.)

The tyre brake is for use when travelling and is always to be used when firing. It consists principally of two brake arms, two cranked levers, connecting rods and an actuating screw. The brake arms are pivoted at one end to a bracket on the trail and provided at the other end with the service cast-iron brake block, which acts on the wheels. Each of the cranked levers is pivoted to brackets on the axletree, one on each side of the carriage body; one arm of each lever is connected in front of the axletree by a connecting rod; the outer arm of the right-hand lever is provided with a nut, through which the front-end of the actuating screw passes, the other end of the screw being linked to the right brake arm. The outer arm of the left-hand lever is connected to the left-hand brake arm by a rod and eccentric link; a releasing lever, with an eccentric pivoted to the connecting rod and link, enables the brake to be quickly released when required. When travelling, the lever is secured by a quick release strap to the left tensile stay, the connecting rod being kept in position by a leather tie passed round it and the left tensile stay where they cross.

The brake arms are actuated by the handle at the end or by the cross handle near the centre of the actuating screw.

SHIELD.

The *Mark II* shield is of steel. It is in three parts, the upper and lower portions of which are hinged. The main portion is attached to the axletree by supporting brackets and to the trail by a flange with bolts. The lower portion, when travelling, is secured to the trail by a

pawl, with a releasing lever and locking pin. The upper portion is lowered when travelling. The sight opening is provided with a hinged shutter for protection of the gunlayer when the rocking-bar sight is not in use ; it is raised or lowered by a lever.

Leather cases and fittings are provided for carrying on the shield and axletree a dial sight, field clinometer, sight clinometer, spare parts, fuze keys, shovel, aiming posts, breech and muzzle covers, oil can, fuze indicator and tool case. An advance loop is fitted to the centre of the shield.

The *Mark I* differs from the *Mark II* in being formed in two parts and in being strengthened by wood slats.

AXLETREE AND WHEELS.

The axletree (2nd class "C" No. 206) is a tubular steel forging ; it passes through bearings on the carriage body and trail, and is secured by a centre pin which passes through the trail bracket and axletree and two outside pins which pass through the brackets fitting over the axletree against the outside of the carriage body bearings, one either side and the axletree itself. A bracket feathered to each shoulder of the axletree is recessed on its outer face for the reception of an L-shaped leather ring, which is secured by a steel plate. The L-leather envelopes the inner end of the pipe box and prevents the ingress of dirt, dust, &c. The outer end of each arm is fitted for a linch pin and an adjusting collar, which has a number of recesses (through which the linch pin passes) cut in one face ; the recesses are of varying depths, from 0.2-inch to 0.5-inch, increasing by 0.05-inch, so that any reduction in the length of the pipe box, due to wear, may be adjusted.

The axletree is braced by a tensile stay on either side ; the front-ends of the stays are attached to the axletree brackets while their rear-ends are bolted to the brake band on the trail.

The wheels are 2nd class "C" No. 45, 4-feet 8-inches diameter, with steel flanges, removable P.B. pipe box and a 3-inch steel tyre with rounded edges. The flanges are of corrugated steel, connected by bolts which pass through the feet of the spokes. The inner flange is fitted with a steel ring to strengthen it and the outer flange with a centring ring. The pipe box passes through the centre of the flanges and is secured by a nut, which is prevented from working loose by a flat spring fixed to the outer flange which engages with one of a number of ratchet teeth on the rim of the nut. For future manufacture the spring and ratchet teeth will be replaced by a locking plate, which fits over the octagonal nut and has two arms through which it is bolted to the flange, the nave bolts being used for this purpose. A dust cap is screwed on the outer end of the pipe box ; it encloses the adjusting collar, linch pin and the end of the axletree arm. The inner face of the cap is recessed for the reception of a corresponding projecting ring on the nut, the cap being secured to the nut by a split keep pin. The pipe box is provided with a lubricating hole which is closed with a $\frac{1}{2}$ -inch screw.

The drag washer is free to revolve round the nut and is secured by the dust cap.

On an emergency a 2nd class "C" No. 200A wheel may be used to replace a No. 45 wheel.

The lifting jacks will be applied from the front of the carriage under the outer hinges of the shield, when it is required to remove the wheels.

SIGHTING.

The carriage is fitted on the left side with a rocking-bar sight with sight clinometer. It is also provided with a No. 7 dial sight and No. 2 carrier.

ROCKING-BAR SIGHT.

(Plate X.)

The rocking-bar sight consists principally of a rocking bar and a sight bar. The rocking bar is pivoted horizontally at the front-end to an arm on the left trunnion of the cradle. A bracket is riveted to the underside at the rear-end to carry a sight clinometer. An open square socket is formed in the bracket for the reception of a similar shaped projection on the arc bracket of the range gear, by which the reciprocating motion of the elevating screw is conveyed to the bar. The rear-end is provided with a crosshead in which works a traversing screw (with milled heads) and a nut which enables 5-degrees of deflection right or left to be given to the sight bar. Degrees of deflection are marked on a scale plate and minutes in multiples of 5 on a micrometer collar fixed to each of the milled heads of the traversing screw.

The sight bar is pivoted vertically about its centre to a socket with an adjustable bush in the rocking bar. The rear-end of the bar is fixed to the traversing nut. The nut on the traversing screw is in two parts having a spring inserted to keep the halves apart; the object of this arrangement is to take up backlash in the deflection gear due to the wear of the screw. Two holders with caps secured by spring clamps are fitted to the bar. The holders originally carried a sighting telescope, the use of which, however, has since been discontinued with field artillery. The rear holder is fitted with a notched-leaf hindsight, which is used in conjunction with an adjustable acorn-pointed foresight at the front end of the bar, for open laying, and a cap with chain is provided for the protection of the foresight when not in use. The rocking-bar sight is removable, being attached to the trunnion arm and arc bracket by nuts and pins.

For future manufacture the sight bar will be fitted with an adjustable supporting bracket for attachment of a No. 1 collimator and a rubber eyepiece for the use of the gunlayer. A base plate is secured to the side of the sight bar by fixing screws, and the collimator supporting bracket is attached to the base plate by two adjusting screws. Two plates are provided for the purpose of locking the bracket and collimator, respectively. The rubber eyepiece with its steel bracket fits in the rear holder.

The permanent angle for drift is given by the axis of the cradle trunnions being inclined at an angle of $1\frac{1}{2}$ -degrees, the left trunnion being the lower, so that as elevation is given, the gun muzzle moves to the left the necessary amount to correct for drift.

COLLIMATOR, No. 1.

The No. 1 collimator consists of a metal body in which are mounted a lens and wedge-shaped window. At one end of the lens an arrow point is marked, which, being in the focal plane of the lens, will, when seen through the lens, appear to be at an infinite distance.

The wedge-shaped window transmits light into the lens, thus illuminating the arrow point.

Use.

With the layer's head a few inches from the collimator and one eye closed, the sight is traversed until the arrow point appears exactly on the aiming point. It is very important that when using the collimator one eye should be kept closed, otherwise considerable errors in laying may result.

CLINOMETER, SIGHT.

(Plate X.)

The sight clinometer is used to allow for the "angle of sight"; it admits of 20-degrees elevation or 20-degrees depression, and is so constructed that it can be readily attached to its carrying bracket. The *Mark I* sight clinometer consists principally of a cradle with a worm spindle and a toothed arc with a spirit level. The cradle is fitted on the underside with spring clips for the purpose of attaching the sight clinometer to its carrying bracket, the clips are actuated by means of a spiral spring placed horizontally between them, and the top of the cradle is provided with radial grooves in which the toothed arc slides. The worm spindle passes through the centre of the cradle and is supported at each end by movable bearings, one of which is pivoted to the cradle and the other is free to slide in grooves for a limited distance, so that the worm on the spindle may be disengaged from the teeth in the arc when necessary for quick setting. The worm is kept up to its work by a flat spring, which is attached at one end to the cradle, the other end taking a bearing on the underside of the spindle. An adjustable micrometer collar, graduated to read minutes in multiples of 5, is attached to each end of the spindle. The arc consists of a toothed segment with a spirit level above, fitted with "bubble spirit glass 'L'"; it slides in the grooves on the cradle and the teeth engage with the worm on the spindle. An adjustable reader is attached to the arc for reading the elevation and depression scales on the cradle.

The *Mark II* sight clinometer is generally similar to the *Mark I*, from which it differs in minor details in order to facilitate manufacture.

The *Mark II** sight clinometer is the *Mark II* converted by the

replacement of broken "L" bubbles by the "Bubble, spirit glass 'P'"; the letter "R" is painted in red on the cradle, immediately below the zero mark of the degree scale, signifying that the bubble is radium treated.

The *Mark III* sight clinometer is generally similar to the *Mark I*, except that it is fitted with the "Bubble, spirit glass, 'P,'" and for the purpose of readily distinguishing it from the *Mark I*, the letter "R" is painted in red on the cradle. In the case of *Mark I* sight clinometers which have had broken "L" bubbles replaced locally by "P" bubbles, the *Mark* is advanced to *Mark III*, and the letter "R" painted in red on the cradle, signifying radium treated.

The *Mark IV* sight clinometer is generally similar to the *Mark III*, from which it differs in the design of clip attachment. The clip attachment is constructed so that the spiral spring is mounted in a perpendicular position and cannot possibly become detached without the clips being released by hand. The great advantage this method of spring attachment possesses over the horizontal method is that the sight clinometer is not apt to jump out of its carrying bracket when the gun is fired as often occurs with the *Marks I* to *III*, sight clinometer.

In future manufacture, sight clinometers will not be fitted with radium treated bubbles.

Existing sight clinometers will have the radium treated bubble replaced, as they become broken, by bubbles of the same size and sensitiveness, viz., the "L" or "N" or by the "P" from which the radium has been removed. When fitted with a non-luminous bubble, the letter "R" on the body of the sight clinometer signifying radium treated, will be barred out and in the case of the *Mark II** the *Mark* will revert to *II* and in that of the *Mark III* to *I*.

As issues of the *Mark IV* sight clinometer fitted with the "P" bubble have not been made to the Service, it will now be fitted with the "L" bubble before issue, but this alteration, however, will not affect the *Mark*.

SIGHT, DIAL, No. 7.

(*Plates XI and XII.*)

The No. 7 dial sight is employed for both direct and indirect laying. The upper part can be revolved horizontally through a complete circle independently of the eyepiece, thereby allowing the layer to see objects in any direction without moving the position of his eye. Owing to the height of the sight the layer can lay on objects directly behind him, the line of sight being above his head. A coned seating in the sight rests on a coned projection on the carrier.

Mark III.—The optical arrangements are so designed that an object viewed through the sight is always seen erect. They consist of:—

F. The upper prism which is mounted in the upper portion of the sight. Its face can be turned in any direction with reference to the eyepiece K, the angle between the two being indicated on the dial plate and by means of a reader on the bracket N.

G. The centre prism which by means of bevel gearing is made to revolve at half the speed of the upper prism F. This arrangement ensures the object laid on always appearing erect.

H. A double reflecting roof prism.

J. The object-glass.

K. The eyepiece, with two eye lenses.

M. A glass diaphragm, upon which are engraved vertical and horizontal lines with gaps near their centres; a radium dot is placed just below the optical centre on the vertical graticule and is for use at night. A glass window in the eyepiece allows the lines to be illuminated at night.

The magnification of the system is four diameters, and the field of view is 10° . There are no arrangements for focussing the sight.

The principal mechanical parts are the following:—

B. *The supporting pillar*, in which are suitably mounted the eyepiece K fitted with a dermatine eyeguard, the lower prism H and the object-glass J. The “plug, supporting pillar,” V, is screwed into its lower end and on it is a castellated nut, which is prevented from unscrewing by a split-pin. Near the upper end of the supporting pillar is a coned seating W, which fits accurately on to a coned bearing on the carrier.

The projection X, which fits into a slot in the carrier, prevents the sight revolving, and is also the means by which the dial sight is adjusted for line when in use with carriers fitted with dial sight adjusting screws and lock nuts.

C. *The worm-wheel bracket* is firmly secured to the supporting pillar B. In it is mounted the slow motion traversing gear, which consists principally of a worm spindle S, the worm on which engages with the worm-wheel D. On either end of the spindle is mounted a milled head and an adjustable micrometer scale drum. The drums are graduated in opposite directions in divisions of 10-minutes, *Right* angles being denoted by white lines on a black background and *Left* angles by black lines on a brass background. For future manufacture the distinctive marking will be omitted, the graduations being filled in with black wax on a bright metal background, *Right* and *Left* angles being indicated by the letters “R” and “L” respectively. The drums can be adjusted by loosening the caps inside the milled heads and turning them independently of the milled heads. The readers for the drums are on the worm-wheel bracket. Each turn of the worm spindle moves the upper part of the sight through 5° . The worm spindle is mounted in an eccentric, which, when turned by raising a lever near the left drum, throws the worm out of gear with the worm-wheel. This enables the upper part of the sight to be revolved rapidly. The rear surface and four screws are for the attachment of the upper portion of the deflection bracket of the No. 1 special and Nos. 2, 4 and 5 dial sight carriers, but in future manufacture carriers will not be provided with deflection brackets, and all deflection angles will be applied through the dial sight.

D. *The worm-wheel* has teeth cut on its lower portion which engage with the worm spindle S. It extends upwards and is firmly secured to the upper prism holder E and the dial plate A by screws, &c.

Y. The centre prism holder fits accurately in the supporting pillar B. To it is attached the prism mount P, in which the centre prism G is firmly held.

The prism holder is free to revolve and is forced to do so at half the speed of the upper prism holder E, by means of three bevel wheels. The axis of the vertical bevel wheel Z is formed on a projection from the prism holder. This wheel engages with the lower bevel wheel Z¹, which is fixed to the supporting pillar and also with the upper bevel wheel Z², which is fixed to the upper part of the sight. When the upper part of the sight is revolved the axis of the centre bevel wheel and consequently the central prism, are forced to revolve at half the speed of the upper part of the sight.

E. The upper prism holder, as previously mentioned, is rigidly attached to the dial plate and worm-wheel. In it are suitably mounted the upper prism and a glass window.

A *Mark I* diaphragm is hinged to the case of the upper prism holder by means of which the focus and parallax at short distances can be corrected without any appreciable loss of light.

The diaphragm, which is fitted with a shutter, is only for use at short distances of, approximately, 20-yards or under.

A spring is provided which retains the diaphragm in position when closed.

In the centre of the diaphragm is a hole, 0.25-inch in diameter, in the shutter one of 0.125-inch diameter.

If the object to be viewed is only a few feet away, the shutter is to be used and the object viewed through the small hole.

When the dial sight is used at a distance of more than 20-yards the diaphragm is to be lowered from the front of the window.

The *Mark II* diaphragm differs from the *Mark I* principally in the following particulars :—

The hinge pin is of strengthened pattern.

The shutter can be operated from the outside instead of it being necessary to lower the diaphragm.

The spring retaining the diaphragm is of an improved design and also retains the shutter.

To enable the line of sight through the upper prism to be elevated or depressed, a small toothed arc is attached to the mount of the prism. The teeth of this arc are engaged with a worm spindle R. At the top of this spindle is mounted a milled head with adjustable drum, engraved with a zero mark. The reader is engraved on the prism holder; 17° elevation or depression can be given. The letters "E" and "D" are engraved against each numbered graduation to denote "Elevation" and "Depression," respectively.

A crosshead with open sights (or view finder) is mounted on the right side of the upper prism holder. Its movement is regulated by that of the upper prism, but, as the latter has a reflecting surface the former has to move twice as quickly. This is arranged for by a toothed wheel on the prism mount, gearing with a toothed wheel having only half the number of teeth, on the pivot of the crosshead with open sights.

Engraved on the under portion of the crosshead is a zero mark, indicated by an arrow on the upper prism holder.

A. *The dial plate*, as previously mentioned, is firmly fixed to the worm-wheel and upper prism holder. The dial plate is cast with two lug pieces on it to prevent any play between the dial plate and the case, upper prism holder. Two scales, each reading from 0 to 180 in single degrees, are engraved round the dial plate, *right* angles being denoted by white lines on a black background and *left* angles by black lines on a brass background. For future manufacture the distinctive marking will be omitted, the graduations being filled in with black wax on a bright metal background; *right* graduations being indicated by the letter "R," the *left* by the letter "L."

The graduations are read by a reader on the reader bracket. This reader can be adjusted by loosening two screws in its rear surface and moving it to one side. The amount of adjustment that can be thus obtained is approximately $1\frac{1}{2}^{\circ}$ on either side of zero, but instructions will shortly be announced in List of Changes for this adjustment to be increased to 2° for existing sights, whilst sights of future manufacture will have an adjustment of $2\frac{1}{2}^{\circ}$ each way.

The *Mark II* dial sight differs from the *Mark III* principally in the following particulars:—

- (1) The dial plate is not cast with two lug pieces on it.
- (2) The slope of the dial plate is steeper, which causes the reader plate to be slightly lower.
- (3) The boss at the top of the dial plate is slightly smaller in diameter, necessitating a smaller clamping collar and lead lining.
- (4) The vertical scale graduations on the upper prism holder crosshead and the micrometer head, excepting the zero and index marks, are omitted.

Mark I sights differ from the *Mark II* in the following particulars:—

One of the milled heads on the worm spindle is smaller.

A vertical scale, with graduations to 15° elevation and depression is fixed to the upper prism holder and the micrometer scale drum is graduated in intervals of 10-minutes.

Certain internal parts are of steel instead of bronze.

Marks I and II sights are brought up to *Mark III* type when passing through Woolwich for repair.

CARRIER, NO. 7 DIAL SIGHT.

Carrier, No. 7 Dial Sight, No. 2, Mark I.—The No. 2 carrier consists of a steel bar, shaped at its lower end to fit into a supporting bracket on the arc bracket of the range gear. The upper portion is shaped to take the dial sight.

To enable deflection to be given to the sight, a bracket, on which worm teeth are cut, is fixed by screws to the back of the carrier. Gearing with the worm teeth is a worm formed on the centre of a spindle, which works in bearings in a bracket attached to the back

of the dial sight. The worm spindle has milled heads with micro-meter scales, graduated in intervals of 10-minutes and the worm spindle bracket carries a deflection scale plate, graduated to 10° R. and L., the graduations being indicated by an arrow plate attached to the carrier.

The No. 2, *Mark II* is made of cast iron and is generally similar to the No. 2, *Mark I*, except that the deflection bracket is omitted, a projection is formed at the top of the carrier to act as a stop and the diameter of the coned seating is of increased dimensions to enable the dial sight to take a bearing on the side of the cone instead of the top surface. Existing *Mark I* carriers will be modified to approximate to the *Mark II* by having the deflection bracket removed and a stop bracket fitted to prevent the dial sight from turning in the carrier. Carriers thus modified will have a "*" added to the Mark and in the future be known as *Mark I**. A number of No. 2, *Mark I* carriers have been fitted with a stop bracket in accordance with § L. of C. 20,181; this method will be superseded by a simpler method which is described in § L. of C. 23,722, but carriers already modified will not be affected.

INSTRUCTIONS FOR TESTING AND ADJUSTING THE SIGHTS.

The field clinometer, sight clinometer and elevation indicator should be tested daily and after prolonged firing. The alignment tests should be carried out as often as possible.

Any adjustment to optical instruments must be carried out by a qualified artificer.

TEST 1.—TO TEST AND ADJUST THE FIELD CLINOMETER.

To ascertain the index error.—Set the clinometer at zero; place it on the clinometer plane and elevate or depress the gun until the bubble is in the centre of its run; then turn the clinometer end for end.

If the bubble is still in the centre of its run the clinometer is in adjustment. If the bubble is not in the centre of its run bring it so by moving the slider or, if necessary, the arm and slider. One-half of the nett reading is the index error of the clinometer. If the bubble cannot be brought to the centre of its run by this method, the error of the clinometer may be determined by comparison with a clinometer of known error.

To eliminate an index error.—Set the clinometer to read the ascertained index error and place it on the clinometer plane, bring the bubble to the centre of its run by elevating or depressing the gun. Set the instrument at zero, replace it on the clinometer plane and with the instrument in that position bring the bubble to the centre of its run by manipulating the adjusting screw of the bubble tube, the gun remaining as before.

Reversing the instrument end for end should not alter the central position of the bubble; should it do so, proceed as before until there is no change.

The adjustment to the bubble is made by two capstan nuts in the *Mark III*, by three grub screws in the *Marks IV and V*, and by a clamping and adjusting screw in the *Mark VI*.

*To ascertain if the bubble axis remains parallel to the longer axis of the clinometer (Roll test).—*Having adjusted for index error, set the clinometer to read zero, place it on the clinometer plane and bring the bubble central by the elevating gear.

Revolve the clinometer on its longer edges through an angle of 5-degrees to either side, care being taken that the longer edges of the clinometer are approximately parallel to the axis of the gun.

The air bubble should remain central. If it moves from the centre the instrument requires adjustment.

To adjust.—If the bubble travels towards the rack when revolved on its long edge loosen the lower grub screw next to the edge on which it is revolved, tighten the other lower grub screw until the bubble is again central. If the bubble travels away from the rack when revolved, reverse the operation with the lower grub screws. The clinometer should now be tested for index error.

The *Marks IV and V* clinometers can be adjusted in this manner but the *Marks III and VI* are not so adjustable.

These adjustments to clinometers should only be carried out by those qualified to do so.

TEST 2.—TO TEST AND ADJUST THE SIGHT CLINOMETER.

With the sight clinometer bracket horizontal and the sight clinometer reading zero, the bubble of the sight clinometer should be in the centre of its run.

Place the sight clinometer, set at zero, in its bracket and bring the bubble to the centre of its run by the left elevating handwheel. Reverse the sight clinometer end for end; the bubble should still be in the centre of its run.

If the bubble is not in the centre, bring it so by turning the micrometer head. Note the reading and set the micrometer scales to half this reading. Bring the bubble to the centre of its run by the left elevating handwheel. Slacken the nuts securing the micrometer scales and the screws securing the degree scale; shift the micrometer scales and reader to zero and re-clamp.

TEST 3.—TO TEST AND ADJUST THE ELEVATION INDICATOR.

With the sight clinometer reading zero and the bubble in the centre of its run, and with the axis of the gun inclined at the necessary angle to the line of sight to compensate for jump and droop, the elevation indicator should read zero. If the jump of any particular equipment has not been determined it will be taken as + 15-minutes.

Place a shell in the chamber to take up play in the elevating gear.

Set the M.V. corrector at 1615.

Set the sight clinometer at zero and bring the bubble to the centre of its run by the left elevating handwheel; place the field clinometer set at the correction for jump on the clinometer plane at the muzzle,

are to the front. Bring the bubble of the field clinometer to the centre of its run by the right elevating handwheel. The elevation indicator should read zero.

If the elevation indicator does not read zero, slacken the nut, revolve the indicator until it reads zero and re-clamp.

Set the M.V. corrector at the muzzle velocity of the gun.

ALIGNMENT TESTS.

Before beginning these tests the following preparations should be made :—

- (i) Place the carriage on a firm platform and manipulate it until it is level transversely. *See* (iv).
- (ii) Select a well-defined object at least 1,500-yards distant on which to lay.
- (iii) If this distant object cannot be found, set up the target testing sights (*see* Plate XIII) about 50-yards in front of the gun at right angles to the axis of the bore.
- (iv) If the carriage cannot be levelled transversely the top of the dial sight carrier and the target testing sights should be sloped to the same angle as the carriage.
- (v) Remove the striker and fix cross wires at the muzzle of the gun. (The cross wires must be removed on completion of test otherwise accidents may occur when firing.)
- (vi) Set the elevation indicator, the cowl of the dial sight, the dial plate and micrometer scales of the dial sight and the deflection scale of the open sight at zero.

TEST 4.—TO TEST AND ADJUST THE DIAL SIGHT AND OPEN SIGHT FOR LINE.

The lines of sight through the dial sight and open sights should be parallel to the axis of the bore as regards line.

Lay the bore on the distant object for line by the left elevating handwheel and the traversing gear, using the inter-section of the cross wires as a foresight and the hole in the firing-hole bush as a hindsight. The lines of sight through the dial sight and open sights should be on the distant object.

When using the target testing sights (*see* Plate XIII) lay the bore on point "B"; the dial sight should be on line "D," and the open sights on point "S."

If the dial sight is not in alignment turn the micrometer heads of the sights until it is; loosen the caps inside the milled heads and, without turning the milled heads, put the scales back to zero and tighten up the caps. Slacken the screws securing the dial plate reader, move the reader to zero and tighten up the screws. If the open sights are not in alignment adjust by turning the adjusting bush on the pivot of the sight bar and tighten up the fixing screw and adjusting bush.

TEST 5.—TO TEST AND ADJUST THE OPEN SIGHTS FOR ELEVATION.

The line of sight over the open sights should be parallel to the sight clinometer set at zero.

Set the sight clinometer at zero and bring the bubble to the centre of its run by the left elevating handwheel; place the bar testing sights on the open sights, and place the field clinometer set at zero, on the bar testing sights. The bubble should be in the centre of its run.

If the bubble is not in the centre, bring it so by slackening the fixing screw and screwing the foresight up or down and re-clamp.

LIMBER, Q.F. 18-PR., CARRIAGE.

(Plates XIV and XV.)

The *Mark II* limber consists of a steel frame, a limber hook, a 2nd class axletree, draught fittings, an ammunition box and two field wheels.

The frame consists of four futchels, connected at the front end by a trough-shaped splinter bar and at the centre by stays. Platform and foot boards are fitted to the top and draught hooks for the swingle-trees to the front of the outer futchels. A steel limber hook, No. 31, is riveted to the rear-end of the inner futchels.

The axletree, No. 252A, is of weldless steel tube: it is fixed by flanges to the futchels. The linch pin and adjusting collar are similar to those for the carriage.

The fittings for draught consist of a No. 17 *Mark III* pole, a No. 3 supporting bar and two No. 11 swingle-trees. The pole and bar are for use with the R.A. pole draught breast harness. The pole is 12-feet 4½-inches in length over all; the front-end is protected by steel wrapping plates; a U-shaped tug is passed through the pole from the underside and secured by a nut on the top. The tug forms a stop for the pole bar, and its position from the point of the pole may be varied from 14½-inches to 29½-inches, in distances of 3-inches, according to requirements. The pole bar is 3-feet 9½-inches in length, fitted at the centre with an oval loop, formed to pass over the front-end of the pole and butt against the tug. Two links are fitted on each side of the loop, by means of which the bar is attached to the neck piece of the harness. The swingle-trees are 2-feet 6-inches long.

The ammunition box is of steel and opens at the rear; it is constructed to carry 24 rounds of "fixed" ammunition, is fitted with guard irons, Nos. 25 "near" and 26 "off," is secured to the frame by rivets and supported by side connecting plates and gusset plates. Internally it is fitted with 24 tubular baskets secured by leather stops. The baskets are shaped internally to hold one round. A compartment is formed in the centre for two wood trays for small stores. The lid (the inside of which is covered with a leather or waterproof canvas pad to prevent the ingress of water) is hinged to the bottom of the box and is provided with a shield plate of the same width, which hangs vertically below the lid when opened. The shield plate is hinged to the lid, and when closed, the former is folded over the latter, which is secured by catches on each side of the box.

Spring clips are attached to the front of the box for carrying two rifles, in canvas covers secured in position by means of "quick release" securing straps.

The limber is fitted on the underside with wire net receptacles for carrying canvas water buckets, with fittings to carry a 3-lb. grease tin and two No. 3 lubricating cans (one for Rangoon and one for buffer oil); also various stores as shown in Packing Diagram, page 35.

The wheels are the same as those described for the carriage.

Half the limbers per battery will be fitted with loops for kicking straps.

The *Mark I* limber differs from *Mark II* in being fitted with brass tubes instead of tubular baskets for carrying the ammunition.

LIMBER, Q.F. 18-PR., WAGON.

(Plates XVI and XVII.)

The *Mark II* wagon limber differs from the carriage limber principally in the form and capacity of the ammunition box, which is constructed to carry 38-rounds and one tray for small stores. It is provided at the rear with three lids, one on each side and one in the centre. The side lids are fitted with shield plates, which hang below the limber frame, as in the carriage limber; the centre lid is hinged at its upper edge and rests on the top of the box when open.

The *Mark I* limber differs from *Mark II* in being fitted with brass tubes instead of tubular baskets for carrying the ammunition.

WAGON, AMMUNITION, Q.F. 18-PR.

(Plates XVIII and XIX.)

The *Mark II* wagon consists of a steel frame, hollow box perch fitted with a perch eye, steel ammunition box, brake gear, 2nd class axletree and two field wheels.

The frame consists of two flanged sides connected by stays, platform and foot boards are fitted to the sides and perch in front, and a shelf is fitted under the platform board on each side of the perch to carry a 3-lb. grease box.

The perch, which is connected to the frame by the side stays and platform boards, is plugged at the front end with hard wood. It is fitted with locking plates, lifting handles and a No. 13 perch eye.

The ammunition box is the same as for the wagon limber, except that it has only one lid fitted with a shield plate similar to that for the carriage limber. Fittings are also provided on top of the box in rear for the fuze indicator.

NOTE.—To facilitate the extraction of ammunition from the baskets the leather work of the basket should be kept soft by grease. The baskets will be tested periodically, and if necessary, rectified by the insertion of a dummy round.

A tire brake is provided, which acts on the front of the wheels and is actuated from the rear by a handwheel.

The wagon is fitted to carry a spare jointed pole and the various stores as shown in Packing Diagram, page 36.

The axletree is 2nd class "C" No. 252A. The wheels are similar to those for the carriage.

A "Connector, limbering," consisting of an axletree hook with connecting pin and a coupling hook with two links, is attached to the axletree as a component of the wagon and affords a ready means of connecting the carriage to the wagon in cases where only one limber is available.

The *Mark I* wagon differs from *Mark II* in being fitted with brass tubes instead of tubular baskets for carrying the ammunition.

AVERAGE WEIGHTS.

(Fully packed with ammunition and stores, but without men or personal equipment.)

					Weights.		
					cwt.	qr.	lb.
Carriage, with gun	....	....	....	....	25	0	21
Limber { carriage	....	....	....	....	15	1	0
{ wagon	....	....	....	....	19	0	0
Wagon, ammunition { with spare jointed pole	....	....	....	....	19	3	17
{ without spare jointed pole	....	....	....	....	19	1	17
Carriage and gun with limber	....	....	....	....	40	1	21
Wagon, ammunition { with spare jointed pole	....	....	....	....	38	3	17
and limber { without spare jointed pole	....	....	....	....	38	1	17
Carriage and limber { weight on fore wheels	....	....	....	....	16	0	21
{ weight on hind wheels	....	....	....	....	24	1	0
{ weight on fore wheels with spare jointed pole	....	....	....	....	20	2	5
{ weight on hind wheels with spare jointed pole	....	....	....	....	18	1	12
Wagon, ammunition and limber { weight on fore wheels without spare jointed pole	....	....	....	....	20	0	14
{ weight on hind wheels without spare jointed pole	....	....	....	....	18	1	3
{ without men	....	....	....	....	—	—	24
Weight on pole at { carriage and { with 2 men on	....	....	....	....	—	1	4
tug 3rd hole { limber { limber	....	....	....	....	—	—	20
from front end { wagon and { without men	....	....	....	....	—	—	20
(limbered up) { limber { with 2 men on	....	....	....	....	—	1	0
Carriage—	....	....	....	....	—	1	0
Pressure of trail on ground	....	....	....	....	1	0	8
Pressure of trail on limber hook	....	....	....	....	—	3	4
Wagon, ammunition—	....	....	....	....	....	....	....
Pressure of perch { with spare jointed pole	....	....	....	....	1	3	16
on ground { without spare jointed pole	....	....	....	....	1	3	4
Pressure of perch { with spare jointed pole	....	....	....	....	1	0	20
on limber hook { without spare jointed pole	....	....	....	....	1	0	0
Wheel, 2nd Class "C" { No. 43	....	....	....	....	1	2	10
{ „ 45	....	....	....	....	1	3	10

DIMENSIONS, &c.

				Carriage and Limber.		Ammunition Wagon and Limber.			
				ft.	ins.	ft.	ins.		
Height	{	to axis of gun	.....	3	0.86	—	—	
		to line of sight	.....	3	9.11	—	—	
		maximum {	carriage, without dial sight	4	8.75	—	—	
			limber	4	9	—	—	
Width, maximum	{	wagon and limber	.....	—	—	5	2	
			.....	6	3	6	3	
Length of	{	carriage with gun	.....	13	8	—	—	
		limbers {	carriage {	with pole	14	2	—	—
			wagon {	without pole	5	4.5	—	—
				with pole	—	—	14	2
				without pole	—	—	5	4.5
		wagon	.....	—	—	8	5	
Length	{	between axletrees	.....	9	11	7	4.75	
		with pole (end of pole on ground)	.....	27	4.5	21	5.5	
		without pole	.....	18	9	12	11	
Greatest projection beyond track of wheels				.....	—	6	—	
Wheels	{	track	.....	5	3	5	3	
		height	.....	4	8	4	8	
Space required to turn in				32	0	28	0	
				deg. min.		deg. min.			
Angle of	{	lock	.....	71	0	64	0	
		trail (spade buried)	.....	14	18	—	—	
Upsetting angle				39	30	35	30	
Elevation, maximum				16	0	—	—	
Depression, maximum				5	0	—	—	

PART IV.

LIST OF STORES AND PACKING DIAGRAMS.

LIST OF STORES.

CARRIAGE.

Articles.	No.	Where carried.
Axe, pick....	1	Under trail.
Brush, breech screw	1	In tool case, rear of shield.
Can, lubricating, No. 9	1	In wood block, rear of shield.
Carrier, No. 7 dial sight, No. 2	1	On shield, in case.
Case, keys, setting fuze....	1†	On shield.
Case, field clinometer, No. 1	1*	On shield.
Case, No. 7 dial sight and No. 2 carrier, Q.F. 13- and 18-pr.	1	On shield.
Case, sight clinometer	1†	On shield.
Case, spare parts	1	On shield.
Case, spare sight clinometer	1§	On left tensile stay.
Case, tools	1	On axletree.
Cleaner, piasaba, No. 18	1	In tubular trail.
Cleaner, wool, No. 1	1	In tubular trail.
Clinometer, field....	1*	On rear of shield.
Clinometer, sight { (spare) }	1§	In case, on left tensile stay.
Cover, breech	1	In case, on shield.
Cover, muzzle, No. 1	1 }	On gun. When not in use,
Cover, eccentric, brake gear	1 }	strapped to front of shield.
Drift, No. 12	1	On eccentric of brake gear.
Funnel, filling, cylinder, No. 1	1	In leather case, on shield.
Gauge, striker protrusion, No. 1	1	In tool case, rear of shield.
Hammer, claw, 24-oz.	1	In leather case, on shield.
Implements, ammunition—		
Keys, No. 18 (setting fuze)	2	In tool case.
Indicator, fuze, Q.F. 18-pr.	1	On shield.
Key, removing jammed cartridges, Q.F. 13- and 18-pr.	1§	In tool case, "A" sub-section.
Lanyard, firing, No. 15	1	In tool case, rear of shield.
Oil, Rangoon pts.	½	In lubricating can.
Ordnance—		
Catch, retaining, breech screw (spare)	1†	In leather case, on shield.
Pin, axis, catch, B.M. lever (spare)	1*	In leather case, on shield.
Pins, firing (spare)	2	In leather case, on shield.
main (spare)	1†	In leather case, on shield.
Springs { safety catch (spare)	1†	In leather case, on shield.
trigger (spare)	2††	In leather case, on shield.
tripping piece (spare)	1	In leather case, on shield.
Striker (spare)	1	In leather case, on shield.
Pliers, flat nose pr.	1	In tool case, rear of shield.
Posts, aiming	2	On front of shield.
Ropes, drag, heavy, 30-feet pr.	1	On front of shield.
Screwdriver, G.S., 4-inch	1	In leather case, on shield.
Shovels, G.S.	1	Right tensile stay.
Sight, dial, No. 7	1	On shield, in case.
Spanner, adjustable, 15-inch	1*	In tool case, rear of shield.
Spanner, adjustable, 11-inch	1	In tool case, rear of shield.
Spanner, No. 244	1	In tool case, rear of shield.
Spanner, hydraulic buffer, No. 122	1	In tool case, rear of shield.
Spanner, hydraulic buffer, No. 123	1	In tool case, rear of shield.
Spanner, hydraulic buffer, No. 129	1	In tool case, rear of shield.
Spanners, H.B., No. 162, with tommy, No. 37(a)	1	In tool case, rear of shield.
Spanners, H.B., No. 163 (a)	1	In tool case, rear of shield.
Spanners, H.B., No. 165, Mark II (a)....	1	In tool case, rear of shield.

* Per section.

† Components of carriage.

‡ 1 per 3 guns.

†† 8 per battery.

§ Per battery.

(u) Carriages fitted with tank for hydraulic buffer.

LIMBERS.

(Carriage and Ammunition Wagon.)

Articles.	Carriage.	Wagon.	Where carried.
Axes { felling, curved helve	1	—	On platform board.
pick	1	2	Under centre futchel limber.
Bar, supporting draught pole, No. 3 (spare)	1	1*	On platform board.
Blankets, G.S.	2	2	On top of limber box.
Box, grease, 3-lb.	1	1	Under platform board, "near" side.
Box, dust cap, and drag washer....	1§	—	On top of limber box, at rear.
Breast piece	1	1	On platform board.
Brushes, water, carriage	1	1	Under platform board, "near" side.
Buckets, water, G.S., canvas	12	6	In wire net receptacles.
Cans, lubricating, No. 3 { for Rangoon oil	1	1	} Under platform board, "off" side.
for mineral oil	1	1	
Cap, dust, 2nd class "C" capped wheels, No. 1 (spare)	1§	—	In box, strapped on top, at rear of limber box.
Carrier, ammunition, Q.F. 13- and 18-pr.	1	1	Under blankets.
Cartridges, Q.F. 18-pr.	24	38	In ammunition box.
Case, No. 3, lubricating can	2	2	Under platform board, "off" side.
Clips, cartridge, Q.F. 18-pr.	24	38	On cartridges.
Cloths, sponge	5	5	Under tray, small stores.
Collars, adjusting, 2nd class "C" capped wheels (spare)	1||	—	Tray, small stores, lower.
Covers, rifle....	2	2	On rifles, front of ammunition box.
Crowbars, 4-feet 1-inch	1§	—	On platform board.
Files { smooth { flat, 6-inch	1	—	Tray, small stores, lower.
	1	—	Tray, small stores, lower.
	1	—	Tray, small stores, lower.
second cut, half-round, 6-inch	1	—	
Grease, lubricating lbs.	3	3	In grease box.
Handle, file, small	1	—	Tray, small stores, lower.
Hooks, bill	1	1	Under platform board, "off" side.
Implements, ammunition—			
Holder, cartridge	—	1†	Under tray, small stores.
Keys { No. 17 (fixing fuze)	1†	1	Tray, small stores.
No. 27 (primer)	—	1†	Tray, small stores.
No. 18 (setting fuze)	2†	2	Tray, small stores.
Key, split, flat, 1-in. × 4-in. (spare)	1	—	Tray, small stores, lower.
Line, Hambro'	1	1	On platform board.
Oil, mineral (for buffers) pts.	2	2	In cans, lubricating.
Oil, Rangoon pts.	1½	1½	In cans, lubricating.
Pins, capsquare (spare)	1||	—	Tray, small stores, lower.
Pins, keep, split { 1-in. × 1½-in.	1	—	} Tray, small stores, upper (in "box, spare springs, &c.").
	1	—	
	3	—	
	2	—	
	1	—	
	9	—	
	1	—	
	1	—	
Pins, lynch, 2nd class "C" capped wheels (spare)	1§	—	Tray, small stores, lower.

* Per sub-section.
§ Per section.

† Lower tray.

‡ 1 per 3 guns.
|| Per battery.

LIMBERS—*continued.*(Carriage and Ammunition Wagon)—*continued.*

Articles.	Carriage.	Wagon.	Where carried.
Pins, locking shield pawl (spare)	1||	—	Tray, small stores, lower.
Pins, draught, No. 3 (spare)	1	—	Tray, small stores, lower.
Plate, locking nut, pipe box, 2nd class "C" wheels (spare)	1§	—	Tray, small stores, upper.
Plugs, filling hole, hydraulic buffer, No. 12 (spare)	1§§	—	Tray, small stores, lower.
Primers, percussion, Q.F., cartridges, No. 1 (in tin box) (spare)	—	4	Tray, small stores.
Rings, compressed packing, hydraulic buffer (spare)	2	—	Tray, small stores, upper, each in round tin box.
Ropes, drag, light, G.S. pairs	—	1	On platform board.
Screwdriver, G.S., 4-in.	—	1	Tray, small stores.
Screws, lubricating hole, boss-head, $\frac{5}{16}$ -in. $\times \frac{1}{4}$ -in. (spare)	2	—	Tray, small stores, upper (in rectangular box).
Shovels, G.S.	1	2	On platform board.
Spade	1	2†	On off sides of limber box.
Spring, catch, limber and perch hooks (spare)	1‡	—	Tray, small stores, upper.
Spring, disc, No. 62 (spare)	1**	—	Tray, small stores, lower.
Spring, firing gear (spare)	1**	—	Tray, small stores, lower.
Springs, shield pawl (spare)	1||	—	Tray, small stores, lower.
Springs, sight clinometer (spiral) (spare)	1	—	Tray, small stores, upper (in rectangular box).
Springs, plunger traversing lever (spare)	1§§	—	Tray, small stores, upper.
Straps, supporting { front (spare)	2	2	} On platform board.
{ rear (spare)	1	1	
Straps, trace (spare)	2	2	
Stud, retaining stuffing-box, hydraulic buffer (spare)	1	—	Tray, small stores, upper (in rectangular tin box).
Swingletree, Nos. 10A or 11 (spare)	1	1	On platform board.
Tools, packing gland, { collar	1§§	—	Tray, small stores, upper (in round tin box).
{ plug	1§§	—	Tray, small stores, lower.
Tools, withdrawing ring supporting packing, Q.F. 13 and 18-pr.	1*	—	Tray, small stores, upper.
Traces, saddlery pairs	1	1	On platform board.
Tugs, trace (spare)	2	2	On platform board.
Washers, drag, 2nd class "C" capped wheels (spare)	1§	—	In box strapped on top at rear of limber box.
Washers, packing, hydraulic buffer sets (spare)	2	—	Tray, small stores, upper (in round tin box).
Wrench, adjusting No. 7 dial sight and carrier	1§	—	Tray, small stores, upper.

* Per sub-section.

† When limbers are fitted with new pattern hooks.

‡ Per battery.

** 4 per battery.

† 1 on each side of body.

§ Per section.

§§ 1 per 3 guns.

* Per section.
† For each ammunition wagon carrying a spare No. 18 pole.
‡ Per sub-section.
§ When limbers are fitted with new pattern hooks.
§§ 4 per battery.

†† Per battery, carried in A sub-section.
(a) Per battery, carried in F sub-section.
(b) Per battery.
(c) See footnote ||, page 36.
(d) 8 per battery.
(e) When existing bushes become unserviceable they will be considered obsolete.

NOTE.—The spare pole is lashed in position as follows:—

NOTE.—The spare pole is placed in position as follows:

Place the pole in position under the perch with the jointed parts to the rear; care must be taken that the ends do not project to the rear so as to get in the way of the wagon body shield, and prevent it being lowered.

Securely lash the pole by one of the lashings to the front-end of the perch. This lashing should be passed round the pole through the pole tug. (The pole tug should be secured in the front tug hole of the pole.) With the second lashing make fast one end to the iron loop supporting the pole, take a complete turn round each half of the pole and the loop separately, then pass the lashing twice round the ends of the pole and the loop to prevent the pole working to the rear, and make fast.

CARRIAGE AND LIMBER.

LIMBER.

On platform board.

- | | |
|-------------------------|------------------------------|
| 1 bar, supporting pole. | 1 line, Hambro. |
| 1 felling axe. | 1 pair traces, saddlery. |
| 2 straps, trace. | 1 breast piece. |
| 2 tugs, trace. | 2 straps, supporting, front. |
| 1 swingletree. | 1 strap, supporting, rear. |
| 1 crowbar, 4-ft. 1-in. | 1 shovel. |

1 box, grease, 3-lb., under.

 1 oil can, No. 3 (mineral oil) } under.
 1 oil can, No. 3 (Rangoon oil) }

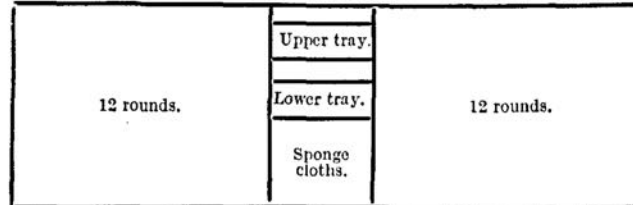
1 water-brush, under.

Fittings for 2 rifles on front of box.

1 billhook, under.

On top.

1 key, No. 18 (setting fuze),*

1 key, No. 18 (setting fuze),*
1 spade.2 blankets.
1 carrier, ammunition.

On top, at rear.

1 box, containing—
1 cap, dust.
1 washer, drag.

6 canvas buckets, under. 1 pickaxe, under. 6 canvas buckets, under.

Contents of upper tray.

- 1 plate, locking nut, pipe box.
- 1 pins, keep, split, various.
- 2 rings, packing.
- 2 screws, lubricating hole.
- 1 stud retaining stuffing-box.
- 1 spring, sight clinometer.
- 1 spring, plunger traversing lever.
- † 1 tool, packing gland, collar.
- 1 tool, withdrawing ring.
- 2 sets washers, packing.
- 1 spring, catch, limber and perch hooks.
- † 1 wrench, adjusting dial sight.

1 key spring lock, in pocket.

CARRIAGE.

Contents of lower tray.

- § 1 collar adjusting wheels.
- 3 files.
- 1 key, No. 17 (fixing fuze)
- 1 key, split, flat, 1-in. × 4-in.
- 1 pin, keep, split, 1-in. × 5-in.
- § 1 pin, capsquare.
- § 1 pin, locking shield pawl.
- 1 spring, disc, No. 62.
- † 1 tool, packing gland plug.
- 1 handle, file, small.
- 1 pin, draught No. 3.
- 2 keys, No. 18 (setting fuze),
- † 1 plug, filling hole.
- † 1 spring, shield pawl.
- 1 spring, firing gear.

Contents of tool case (on axletree).

- 1 brush, breech screw.
- 1 funnel filling cylinder, No. 1.
- 1 hammer.
- 1 key, removing jammed cartridges. ||
- 1 lanyard, firing.
- 1 } spanners { 15-inch. †
1 } { 11-inch.
1 } { No. 244.
1 } { hyd. buffer { No. 122.
1 } { { No. 123.
1 } { { No. 129.
1 } { { No. 162. †
1 } { { No. 163. †
1 } { { No. 165 (Mark II). †

- 1 can, lubricating, No. 9, on shield.
- 1 dial sight and carrier in case } on shield.
- 2 keys, No. 18 (setting fuze), } in case.
- 1 indicator, fuze.

1 spare sight clinometer in case on left tensile stay.

 † 1 clinometer, field (in case) } on shield.
 1 clinometer, sight (in case) }

In case on shield.

- 1 drift, No. 12.
- 1 gauge, striker, protrusion, No. 1.
- 1 screwdriver, G.S., 4-inch.
- 1 catch, retaining breech screw.
- 2 pins, firing.
- 1 spring, main.
- 1 spring, safety catch.
- 2 springs, trigger.
- 1 spring, tripping piece.
- 1 striker.
- † 1 pin, axis, catch, B.M. lever.

- 1 cleaner, plasaba } In tubular trail.
- 1 cleaner, wool } on front of shield
- 1 cover, breech } when not on gun.
- 1 cover, muzzle }
2 aiming posts, on front of shield.
1 pair drag ropes, on front of shield.

* When the guns are parked, the fuze keys should be placed in the tray of the ammunition box.
 † 1 per section.
 § 1 per battery.

† Carriages fitted with buffer tank.
 || 1 per battery, in A sub-section.

WAGON AND LIMBER.

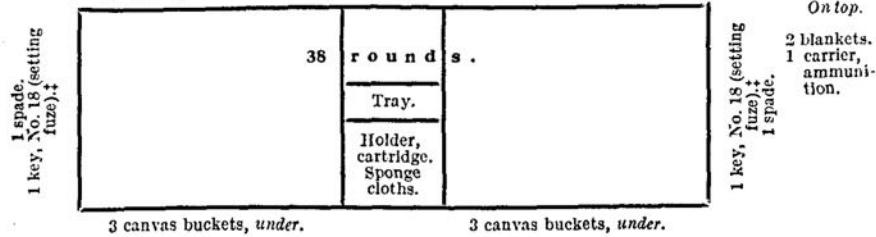
L I M B E R .

On platform board.

1 pair drag ropes.
1 bar, supporting pole.*
2 straps, trace.
1 swingletree.
1 pair traces, saddlery.
1 breast piece.

2 straps, supporting, front.
1 strap, supporting, rear.
2 tugs, trace.
2 shovels.
1 line, Hambro.

1 box, grease, 3-lb., under.
1 water brush, under.
Fittings for 2 rifles on front of box.
1 can, lubricating, No. 3 (mineral oil)
1 can, lubricating, No. 3 (Rangoon oil) } under.
1 billhook, under.



On top.

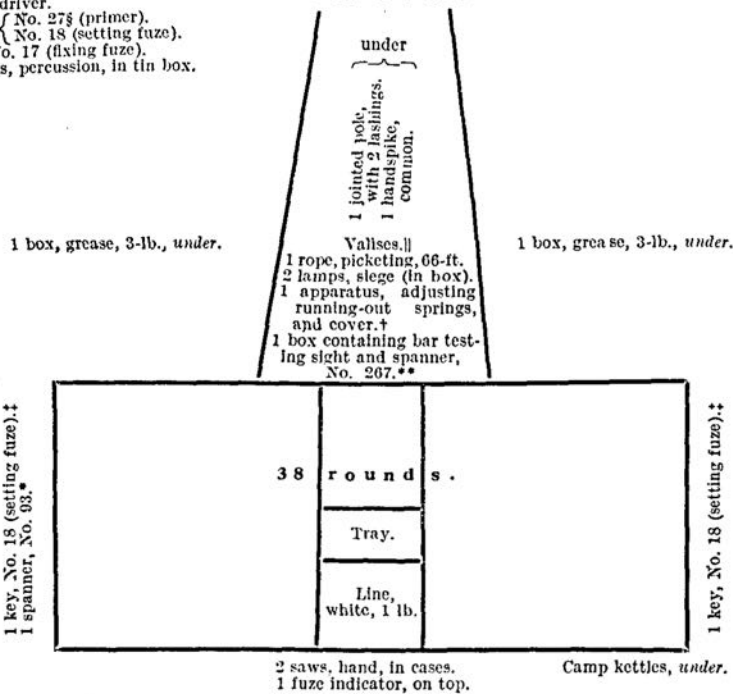
2 blankets.
1 carrier, ammunition.

Contents of tray.

1 screw-driver.
1 } keys { No. 27§ (primer).
2 } { No. 18 (setting fuze).
1 key, No. 17 (fixing fuze).
4 primers, percussion, in tin box.

2 pickaxes, under.
1 key, spring lock, in pocket.

W A G O N .



On top.

2 blankets.

Contents of tray.

1 bush, testing, sighting.**
1 bush, firing hole.†
2 keys, No. 18 (setting fuze).
1 nut, actuating screw, carriage, Q.F. 13 and 18-pr.‡

1 catch, limber hook, No. 2.
1 spindle, catch, limber hook, No. 2.
1 spring, catch, limber and perch hooks.
1 spring, spiral (clock type), range gear.§

* Per sub-section.

† Per battery, carried in A sub-section.

‡ When the guns are parked, the fuze keys should be placed in the tray of the ammunition box.

§ Per section.

|| Vallies:—

Horseshoe	1 on each ammunition wagon	.. A to F sub-sections.
saddlers, No. 1	1 on one of the wagons	.. A, C, and E sub-sections.
Tools { shoing	1 " "	.. A, C, D, and F "
fiters or	1 " "	.. B, D, and F "
wheelers, No. 1	1	.. B, D, and F "

¶ 1 per battery.

** per battery, carried in A sub-section.

PART V.

CARE AND PRESERVATION.

GUN AND FITTINGS.

The breech fittings and also the guides on the jacket by means of which the gun slides in the cradle of the carriage, should be kept clean, oiled or greased and maintained in good working order; all working surfaces must be well lubricated, the fittings being taken off sometimes for this purpose, especially after firing.

Lubricating holes are prepared in the upper side of the carrier to admit of the rear-end of the breech screw in the carrier being oiled. The holes are closed against the ingress of dust by means of a brass plunger and spiral spring which must be pressed down by the spout of the oil can when lubricating.

The breech should be kept covered up, when possible, to prevent dust and grit from getting into the interstices of the breech fittings, which might impede their easy working. A waterproof canvas cover is provided for the purpose.

A gauge, testing clinometer plane and axis of bore is provided for use of Inspecting Officers.

For description and use of gauge, see "Regulations for Army Ordnance Services, Part II."

A "gauge plug, bore, low limit," for provisional condemnation is provided for use of Inspecting Officers, to save time and to avoid unnecessary measurements.

The gauge consists of a cast-iron cylinder having a handle formed at one end to facilitate insertion into the bore. A hole is made through the handle for the attachment of a line for pulling the gauge through the bore.

CARRIAGE, &c.

To remove the hydraulic buffer and springs (gun in position).

NOTE.—Care should be taken that no one is standing in front of the carriage while the operation is being carried out.

1. Place the gun at depression and remove the outer nut (E) securing buffer cylinder, which will allow the cylinder to bear against the outer spring case cap (A).

2. Attach the "Apparatus, adjusting running-out springs," to the controlling plunger (M) and take up the tension on the running-out springs.

3. Remove the piston rod nut (G), the outer spring case cap (A) and filling plug (L).

4. Unscrew gradually the actuating nut of the apparatus and the inner nut (F) securing buffer cylinder (C) as the springs are released.

When the springs are fully extended remove the actuating nut from the screw of the "Apparatus" and remove the springs with parting plates, bearing washers, inner spring case and buffer cylinder from the front, care being taken when removing the cylinder that the filling hole is kept upright to prevent loss of oil.

To replace the hydraulic buffer and springs.

1. Slightly depress the gun. Replace the rear washer (R) at the end of the outer spring case with radius to the rear and insert three of the outer springs and parting plates (J), in correct order.

2. Insert the inner spring case (B), with front washer (P) (radius to the front), and one outer spring in position.

3. Place an inner spring with the rear washer (T) in the inner spring case (radius to the rear), and insert two more inner springs with parting plates (K) in the correct position.

4. Place the front washer (S) (radius to the front) and the remaining inner spring on the buffer cylinder (C).

5. Attach the screw of the "Apparatus, running-out springs," to the plunger (M).

6. Replace the cylinder, care being taken that the filling hole is at the top and that the inner nut (F) securing cylinder is passed on to the screw of the apparatus before the latter enters the lug of the gun. Replace the outer spring case cap (A) and piston rod nut (G) on piston rod (first seeing that the split pin (H) retaining stuffing-box stud is placed in position and the point opened), care being taken to ensure that the featherway (a) in the cap engages the feather on the end of the piston rod (N).

7. Compress the springs, care being taken that the feathers on the end of the cylinder are in the correct position to enter the featherways in the lug of the gun, and that the inner nut (F) securing cylinder is correctly secured by screwing it up while compressing the springs.

8. Screw on the cap (A), remove the apparatus, replace the outer nut (E) securing cylinder and the filling plug (L).

In removing and replacing the buffer cylinder, the gun must be kept at depression or properly secured.

NOTE.—When the gun fails to run out correctly it is probably due to any of the following causes :—

- (i) Weak or broken springs.
 - (ii) Dirt or want of lubrication on either gun guides or cradle guideways.
 - (iii) Distortion of either the guides or guideways.
 - (iv) Buffer gland screwed up too tightly.
 - (v) Too much heated air or gas in buffer ;
- or, if the gun remains practically at full recoil,
- (vi) Front flange of inner spring case is broken.

If the instructions given on pages 41 to 42 for filling the buffers have been carefully carried out, excess of air will only appear after

rapid and continuous firing due to the raising of the temperature of the oil and therefore air should not be released from the buffers without tanks until it has been decided, by the elimination of the other causes, that the failure to run up is due to heated air.

When, in the case of equipments not fitted with tanks the failure to run up is considered to be due to the buffer, the heated air should be allowed to escape. The greatest care must be taken when releasing the air (by easing back the control plunger with gun at maximum depression) not to allow oil to escape. If any oil does escape it must be at once replaced. This is most important as, if the oil is not replaced, violent recoils are likely to occur on resumption of firing, which may result in serious damage to the equipment.

In the case of a buffer fitted with tank the procedure laid down under instructions for filling on page 41 should be followed.

When opportunity arises—with buffers on which tanks are fitted—the gun should be slightly elevated so that any air in the buffer may collect at the front-end and then be allowed to escape by opening the air valve before firing re-commences.

In case (vi) when the failure to run up is due to the breakage of the spring case, special precautions will have to be taken when removing the buffer and springs and are as follows:—

1. Place the gun at depression and run it back to a distance of about 43-ins. from the cradle, the breech being supported on the trail on skidding.
2. The piston rod nut (G) should *not* be removed.
3. Secure a rope to the lug on the breech ring of the gun and man it towards the rear by four men. This will remove the pressure of the outer springs from the threads of the cap on the outer spring case. While the rope is manned, unscrew the cap (A), taking care to keep clear of the muzzle.
4. Ease up the pull on the check rope and allow the gun to run up gradually; at the same time, the motion should be assisted by relieving the weight of the gun at the rear. The outer springs will then have extended to their normal condition.
5. Remove the piston rod nut, cap, the front broken portion of inner spring case and one outer spring, care being taken not to bend the piston rod.
6. Run the gun to the firing position and remove the inner springs and the remaining outer springs by attaching the "Apparatus, adjusting springs," this operation being similar to that before detailed, except that when the inner nut is removed the initial compression of the inner springs will tend to force the gun to the rear about 10-ins.—and a light drag rope should be used to prevent this.

Precautions to be observed to prevent violent recoils and consequent damage to the carriage.

1. Before going into action the "rings, packing, hydraulic buffer" should be carefully examined and exchanged if defective.
2. When tightening up a packing ring the gland should not be screwed home, metal to metal, in the stuffing-box. If the packing

cannot be made tight without doing this, a fresh packing must be used or an additional thin packing ring put in.

3. Buffers should be correctly filled before going into action and examined from time to time to see that they are full.

4. As often as opportunity permits, the gland should be examined, and if necessary, screwed up when the buffer is hot from firing. The packing is then very plastic and is easily squeezed to make a good joint.

5. The gun should be carefully watched during recoil; should the black line marked on the gun be visible at the rear of the cradle, the buffer must be examined as soon as possible. **Should the red line become visible at the rear of the cradle, firing must cease.** If oil is being lost from the buffer and recoil becomes excessive, the packing ring must be either renewed or adjusted. After this operation the buffer should be refilled.

NOTE.—Spare packing rings, soaked in tallow, should be kept ready for immediate use.

To tighten, or renew the packing.

If any leakage of oil takes place at the gland, the packing should be tightened; if this will not stop the leak, the packing must be renewed.

To tighten the packing (gun in position).

1. Remove the piston rod nut (G) and outer spring case cap (A).
2. Screw up the gland (D) with the No. 122 spanner. While in use the spanner must be kept against the face of the gland in order to disengage the retaining stud. The position of the gland after screwing up must permit of the retaining stud re-engaging with a slot in the gland.
3. Replace spring case cap and piston rod nut, taking care that the feather on the piston rod and the featherway in the cap are properly engaged.

To renew the packing ring in the stuffing-box (gun in position).—

1. Empty the cylinder at the controlling plunger (M), and replace the plunger.
2. Unscrew and remove piston rod nut and front cap. Then unscrew the gland and withdraw the outer ring supporting packing with the tools supplied and replace the packing with fresh material, using the metal collar of the packing tools to assist the packing ring over the shoulder of the piston rod. Replace the supporting ring, gland and cap and refill the buffer.

If there is any difficulty in removing the old packing from the stuffing-box, the latter should be removed from the buffer and the packing removed by inserting the plug of the packing tool into the stuffing-box and driving the packing out.

NOTE.—If the gun is not in position, the “Apparatus, adjusting running-out springs” must be attached to the control plunger before the cap is removed.

Pin, keep, split, securing "stud retaining stuffing-box."—On inserting and opening out this pin care must be taken to see that the retaining stud when pushed right back clears the flange of the stuffing-box to permit of its removal. The head and point of the pin should be set to the front if necessary to clear the end of the slot and to allow the stud to go back far enough to clear the stuffing-box.

To fill buffer not fitted with a tank.—Place the gun at extreme depression, remove the filling plug (L), unscrew the control plunger (M) until all threads are disengaged to admit of the escape of air, and fill the cylinder through the filling hole using the leather funnel provided for the purpose, until oil runs out round the control plunger. Screw up the control plunger and replace filling plug. Great care must be taken that no dust or gritty matter is poured in with the oil.

To ascertain if the buffer is full.—There is no method of ascertaining that the buffer is properly filled except by filling it up as described above.

To fill buffer fitted with tank.

- (1) Place the gun at about 5° depression.
- (2) Open the hinged cover on the cap of the outer spring case and unscrew the air valve at the front of the buffer two turns.
- (3) Remove the filling hole plug at the top of the tank and the filling hole plug at the top rear-end of buffer cylinder.
- (4) Unscrew and withdraw the control plunger.
- (5) Measure out 6½-pints of buffer oil and pour it *very slowly* into the buffer cylinder through the rear filling hole.
- (6) With this amount of oil in the cylinder, the tank should be full and there should be a slight leak of oil past the threads of the air valve.
- (7) Replace control plunger and tighten up air valve.
- (8) Bring the gun horizontal and check the liquid level. After standing a little while, oil will commence to overflow at the rear filling hole when the plug should be replaced. The oil in the tank should now be level with the bottom of the hexagon which can be seen on the steel spindle inside the tank. If the oil is above the hexagon it should be drawn off to the above level to allow for the expansion of oil during firing. Replace filling hole plug of tank.

By using this method the buffer can be completely filled in about 30-minutes.

If the buffer already contains some oil, *it should first of all be emptied* and the above procedure carried out.

All the indications of a full buffer and full tank can be obtained with a less quantity of oil than the normal 6½-pints, due to the formation of an air-lock in the buffer. It should therefore be borne in mind that a full tank does not necessarily mean a full buffer. If, however, the 6½-pints be carefully measured and definitely put into the system, it can be assumed with safety that the buffer is full.

The following method is recommended in cases where facilities exist for pulling back the gun and allowing it to run up slowly :—

- (1) Measure out $6\frac{1}{2}$ -pints of oil.
- (2) Elevate gun.
- (3) Remove the filling plug of the buffer tank and *open the air valve* fitted to the front-end of the cylinder.
- (4) Fill the tank.
- (5) Pull the gun back about 2-feet and pour oil into the tank to maintain the liquid level.
- (6) Replace the filling plug of the tank and allow gun to run slowly up.
- (7) Repeat operations (3) to (6) till $6\frac{1}{2}$ -pints of oil have been put in.
- (8) Close the air release valve.
- (9) Check the liquid level in the tank. This should be about 1-inch below the filling hole. If it exceeds this, it means that some oil has escaped through the air release valve, and the quantity lost should be made up. The liquid level, however, should not be less than 1-inch from the filling hole, as the space thus left provides room for the oil to expand when it gets hot.

Alternative liquids which may be used in the hydraulic buffers in case of emergency.

- (1) Pure glycerine or a mixture of equal parts of glycerine and water.
- (2) Any heavy lubricating oil.
- (3) Soapy water or water containing a proportion of soda.
- (4) Clear water may be used in a great emergency only, but it should on no account be allowed to remain in the cylinder for longer than is absolutely necessary, on account of its rusting action.

Kerosene, paraffin, or similar burning oils must on no account be used for this purpose.

GENERAL INSTRUCTIONS.

Elevating gear.—In replacing the bearings and elevating nuts, care must be taken that the open side of the bearing is inserted first in the upper gear and the closed side first in the lower gear (with the teeth of the elevating nuts at the top in both cases), so as to ensure that the gun is always elevated by revolving the handwheels towards the rear, or depressed by revolving the handwheels towards the front.

Range indicator.—The yard and degree scale should be kept perfectly clean, free from grit, burrs or dents, and the revolving surfaces slightly greased.

In replacing the eccentric bush in the arc guides, care must be taken that the bush is placed in such a position as to ensure the least possible play between the teeth of the pinion and the elevating arc. The grooves in the eccentric bush which engage the stop pin are arranged to give eight adjustments, which are numbered 1 to 8, Nos. 1 and 8 representing the minimum and maximum setting respectively.

A certain number of bushes have the grooves numbered 1 to 8, but Nos. 1 and 5 indicate the minimum and maximum setting respectively. The order of adjustment for each pattern bush is as follows :—

—						Nos. 1 and 8. Minimum and Maximum.	Nos. 1 and 5. Minimum and Maximum.
1st adjustment	...	...	...	...	...	1	1
2nd	„	...	...	...	...	2	2
3rd	„	...	...	...	...	3	8
4th	„	...	...	...	...	4	3
5th	„	...	...	...	...	5	7
6th	„	...	...	...	...	6	4
7th	„	...	...	...	...	7	6
8th	„	...	...	...	...	8	5

To exchange a damaged clock spring.—Run the cradle right down to full elevation. Remove the cap covering the left end of the spindle of the range indicator.

Throw the reader back clear and remove the jamming plate, yard scale ring, spring case and barrel with spring from off the spindle.

Push the spindle out a couple of inches to the left, so as to get the pinion out of gear with the arc.

Remove the damaged spring from the casing, insert a new one, replace the barrel and case with spring on the spindle, fitting the barrel on its bearing on the cradle.

Revolve the spring case to the front by hand as far as it will go, thus winding up the spring, slack back a quarter of a turn, hold the spring case firmly and push the pinion through into gear with the arc.

Replace the cap, yard ring and jamming plate and adjust the yard scale ring to the horizontal plane of the gun.

Brake gear.—When the brake is applied, the releasing lever must be housed, as at (F) (Plate IX).

Any wear in the eccentric can be adjusted by screwing up the connecting bolt of the link, eccentric.

When assembling the “Lever, releasing brake,” the hexagon on the spindle portion of the lever must be placed in the eccentric so as to give the maximum amount of throw.

Traversing gear.—The pivot of the crosshead (B) (Plate VII) should be kept properly nitted up and any lateral play in the traversing screw adjusted by tightening the crosshead cap (C) and the check nut (D).

Clamping gear for carriage body.—This clamp should always be on when travelling. To put on the clamp the lever is pulled to the rear, which tightens the nut and draws the carriage down to the trail, thus making it difficult to turn the traversing handwheel.

If, owing to wear, the lever cannot be moved sufficiently to tighten the clamp properly, it must be moved to another position on the octagonal nut.

In action the lever must be pushed as far forward as possible.

Gear, clamping cradle.—Care should be taken that the handle of the clutch spindle is always against the stops when not in use.

The cradle can only be clamped when the gun is at extreme elevation. The gear is intended for use when travelling only.

In replacing the clamping gear the clutches (which are left and right) must be correctly placed on the spindle, *i.e.*, the thinnest portion of the eccentric being to the front and both in the same relative positions on the spindle, so as to engage the bearing on the cradle at the same time.

Pin, locking shield pawl.—It should be carefully noted that this pin is always in proper position when travelling.

Wheels, Nos. 43 and 45.—These wheels are fitted with dust caps, which can be removed with a No. 93 spanner; lateral play between end of pipe box and linch pin can be adjusted by means of an adjusting collar with slots, through which the linch pins pass; the slots vary in depth from 0.2-in. to 0.5-in.; the difference in depth between each slot allows for a wear of 0.05-in.

A linch pin of a capped wheel with the adjusting collar can be used with any ordinary second-class wheel, if required.

An ordinary second-class linch pin and a second-class "C" drag washer can be used on an emergency, with a capped wheel, if the cap be removed.

Sights.—Great care must be taken not to damage the sights when removing or replacing. The parts of the carriage to which the sights are attached must be absolutely clean and free from burrs.

Deflection screw and nut.—Should be kept free from grit and dirt and should be well greased, and if removed for any purpose care should be taken in replacing that the spring which is within the nut (the latter being in halves) is properly compressed before entering the screw. The spring fitted in the deflection nut, to obviate backlash, may be found stronger than is necessary for its work, the result being stiffening an increased wear on the screw. The spring should require a weight of 5 to 7-lbs. to compress it to 0.9-in. The armament artificer will test the spring and shorten it if found necessary.

Adjusting bush.—To be kept clean and well oiled, and if removed for any purpose, steps should be taken to have the sight adjusted to the vertical plane of the gun.

Yard scale ring.—This should be kept clean and oiled, and if removed for any purpose, on replacing it should be set to the horizontal plane of the gun and sight.

Clinometer sight.—Should be kept oiled and free from grit and in perfect adjustment.

Capsquares.—To remove cradle capsquares for cleaning, &c., the carriage body must be traversed as far as it will go to the left to admit the right capsquare key being removed, and to the right to remove the left key.

To remove the outer spring case from cradle.

1. Dismount the gun.
2. Carefully remove the buffer, consisting of the cylinder, piston rod, inner and outer springs and inner spring case.

3. Remove the upper protectors (curved), rough foresight, upper handwheel pinion spindle of the elevating gear and the indicator pinion spindle of the range gear.

4. Unscrew the spring case (by means of a rope and a handspike, or other suitable appliance). Care must be taken, when the first portion of the thread of the spring case is disengaged from the cradle, that the second (and third, with Mark I cases) portion of the thread is properly entered and not cross-threaded, also that the threads are clean and lubricated.

To replace the outer spring case.

1. The converse of the above action takes place in re-assembling the spring case and buffer.

2. Before mounting the gun the "protector slide" on the front-end of the cradle should be removed to prevent the leather portion of the protector forcing out the metal and breaking off the screws when sliding the gun home.

3. After the gun is mounted, replace the "protector slide."

Replacement limits of running-out springs.—The normal free-length of each running-out spring is as follows:—

Inner	..	..	..	..	..	18.58-ins.
Outer	..	..	..	..	..	19.65-ins.

Any one spring, inner or outer, found with a permanent set of $1\frac{1}{4}$ -ins. or more below the normal free length of the spring, will be replaced.

"SIGHT, DIAL, No. 7."

The dial sight when issued from Woolwich is in correct adjustment, watertight, and with all the cells and joints secured with fixing screws.

It is very unlikely that the interior will be required to be cleaned, and the dial sight must on no account be taken to pieces, except by persons holding a certificate from the Artillery College stating that they are qualified to do so.

The body of the dial sight must be cleaned with a clean soft cloth and a little oil, which must be rubbed off afterwards, care being taken that the glass is not touched.

The exterior of eyelens and window should be cleaned with chamois leather, specially kept for the purpose and only by a competent person. Great care must be taken that no oil or grease is allowed to touch the glasses. Fingers when apparently clean and dry may leave marks on the lens which will impair the definition of the telescope.

Dermatine or rubber eye-guards should not be unnecessarily exposed to extremes of temperature, to the sun's rays or to bright light.

Oil and grease will inevitably destroy rubber or dermatine, and prolonged contact with benzol, petrol and chemicals is undesirable. If, however, oil or grease gets on the eye-guard it should be immediately removed, either—

- (a) by wiping with a clean rag soaked in benzol or petrol;
- (b) by washing in water to which a little soap and soda have been added;
- (c) by wiping off with a clean dry rag.

Spare eye-guards should be stored in a box completely filled with French chalk (so as to exclude air). The eye-guards should be packed in such a way that they are not distorted. If French chalk is not available the eye-guards should be kept under water.

If, after being in store for some time, the eye-guards lose their pliability, they can generally be rendered supple when required for use by steeping them in warm water.

LIMBER AND WAGON.

Lids, wagon limber.—In opening and closing the lids of this limber the centre lid must be opened first and closed last.

In order to prevent the wickerwork of the baskets from deterioration from wet (due to condensation), resulting possibly in damage to the ammunition, the lids of the limbers and wagons should be left open in dry weather daily to thoroughly dry the interior. Care is to be taken, however, that dust is excluded as far as practicable. Felt joints are to be kept in good order to exclude water from the interior of the boxes.

LIST OF LUBRICATING HOLES.

Fittings which are provided with oil holes for lubricating purposes.	No. of Holes.	Position of Holes.
CARRIAGE.		
Capsquares (2) each	1	
Carriage body—		
Bearings, axletree (2)	1	In lubricating cup, 1 on each side.
„ clutch spindle (2) ..	1	Inside carriage body, 1 on each side.
Cap, lower bracket of elevating gear	2	In bearing portion for handwheel spindle on left side.
Cradle—		
Body	10	1 each side of keyway gun slide, 7 in sides for oiling sliding surfaces, and 1 on left side at rear, with tube for lubricating handwheel spindle.
Bearing, pinion, spindle handwheel	1	On right side close to handwheel.
Gear, brake—		
Bolts, connect- ing { cranked levers (3), each	1	2 on left side and 1 on right close to shield.
{ eccentric link	1	In head of bolt, right side } near brake blocks.
{ fork, actuating screw ...	1	In head of bolt, left side }
Fork, actuating screw	1	On right side.
Link, eccentric	1	On left side.
Gear, elevating—		
Rod, connecting elevating screw ...	1	In lower end.
Gear, firing—		
Arm, connecting	1	In upper end, left side.
Rod, connecting	2	1 at each end, left side.

LIST OF LUBRICATING HOLES—*continued*.

Fittings which are provided with oil holes for lubricating purposes.	No. of Holes.	Position of Holes.
Bracket, connecting arc, range gear ...	1	On left side.
Bolts, connecting brake arms (2) each	1	In head of each bolt.
Crosshead, traversing gear ...	1	
Lever, traversing ...	1	At jointed end of lever, near plunger.
Sight, rocking bar ...	1	For oiling arm trunnion supporting sight.
Wheels, 2nd Class "C" No. 45 (2) each	1	In inner flange.
WAGON, AMMUNITION.		
Levers, cranked, brake gear { near	1	} Rear of wagon.
{ off	1	

NOTE.—In order to assist in identifying the position of the lubricating holes, the heads of the screws should be kept free from paint.

PART VI.

MISCELLANEOUS STORES.

Apparatus, adjusting running-out springs, Q.F. 18-pr., Marks I and II.—The apparatus consists of a steel screw with locking nut, clip and actuating nut with handle. The method of attaching the apparatus to the hydraulic buffer is as follows :—

- (a) Insert the V-screw thread on the screw into the hole for its reception in the rear-end of the controlling plunger as far as it will go (care being taken that the locking nut is screwed back against the collar on the screw) and tighten up the locking nut against the face of the plunger.
- (b) Place the clip over the screw and insert two studs into corresponding holes in the rear of the spring case.
- (c) Screw the actuating nut, with handle, against the rear-end of the clip.

The *Mark II* apparatus differs from the above in having a differently shaped clip and in the handle of the actuating nut which is made removable to facilitate packing.

Apparatus, illuminating aiming point.—The apparatus consists of the following principal parts :—

- Box, battery.
- Post, ground.
- Box, lamp with reflector.

The *battery box* is made of tinned sheet iron japanned black, and prepared internally to receive 3 batteries, dry, "Y," panel switch with emergency link, base plate with insulating plate and ratchet switch, which is operated by means of a Bowden wire with swivel passed through an opening formed in the box and provided with a removable phosphor bronze spring. A compartment is also provided to hold spare parts, tools, &c. The box is fitted externally with two clamps for securing it to the ground post.

The *post, ground*, is made of tubular iron, 1½-inch in diameter and about 3-ft. 3-inches long, having a steel point at one end for insertion in the ground and a steel plug at the other. One end of a steel spiral spring is attached to the post by means of a ring, and to the other is attached the swivel of the Bowden wire referred to above.

The *box, lamp with reflector* is a tinned sheet iron box japanned black, fitted internally with a 3·5-volt lamp held in a socket secured in an ebonite base to which is fitted a semi-circular trough-shaped reflector. Attached to terminals on rear of ebonite base is one end of a two-way cord conductor, 30-ft. in length, the other end being provided with a two-pin plug. A glass strip 3¼-inches long is fitted into an aperture in the middle of the lid. The top rear of the box is provided with a loop for attachment to the aiming post.

Instructions for use and diagram of circuit are attached on the inside of the lid of the battery box.

When not in use, the whole of the apparatus, with the exception of the ground post, is contained in the battery box.

A waterproof cover for protection of battery box is provided.

Bar, testing rocking-bar sight, Q.F. 13 and 18-pr.—The bar which is for use in testing the sights, as detailed on page 26, is of cast steel; it is 30.75-inches in length, having a countersunk hole in the front-end to fit over the acorn portion of the foresight, the rear-end being provided with a hinged bracket to clip over the sides of the leaf of the hindsight so as to prevent the bar from falling off. A clinometer plane 7-inches in length is formed on the rear-end of the bar on which is placed a field clinometer when carrying out the tests.

When not required for use the bar is contained in a wood box designed for this purpose.

Cleaner, piasaba, No. 18.—The cleaner consists of a brush composed of piasaba or kittool bristles fixed on the middle portion of a 1-inch white hemp rope lanyard. A 1.5-inch diameter lead ball is attached to one end of the lanyard so as to carry it through the bore of the gun. Total length of lanyard is approximately 220-inches.

Cleaner, wool, No. 1.—The wool cleaner is generally similar to the piasaba cleaner described above, from which it differs principally in having a wool sponge fixed in the middle portion of the lanyard instead of a brush.

Clip, cartridge, No. 4.—The clip is made of brass, cross-shaped so as to form four arms the ends of which are turned in to engage with the rim of the cartridge case. The clip protects the cap of the percussion primer. One arm is painted red and is slightly longer than the others, the clip portion being differently shaped so as to spring over the rim of the cartridge. One or two longitudinal ribs may be stamped on the long arm as an alternative. The other three arms may be tinned, copper plated, blackened in oil or galvanized. It has a webbing loop for withdrawing the cartridges from the baskets in the ammunition boxes of the limbers and wagons.

Cover, breech, No. 1.—The cover is made of waterproof canvas and formed to protect the breech mechanism of the gun and the rocking-bar sight; it is secured in position by lacing loops and quick release straps.

Cover, muzzle.—The cover is made of waterproof canvas shaped to suit the muzzle of the gun; it is provided with a leather strap to secure it in position.

Drift, No. 12.—The drift is of steel and is for use in removing keep pins from the mechanism.

Gauge, striker protrusion, No. 1.—The gauge is of steel plate and is for use in gauging the protrusion of firing pins or needles of strikers of Q.F. 6-in. to 12-pr. guns.

Implements, ammunition—Key No. 13, fixing and setting No. 25 fuze.—The key is of steel, one end being annular in shape with a nib piece to fit in the slot provided in the body of the fuze for fixing purposes. The other end is shaped and fitted with a projection to suit the slot in the time ring for setting purposes.

Implements, ammunition—Key No. 17, fixing Nos. 80 and 83 fuzes.—The *Mark II* key is made of steel, one end being shaped to fit over the fuze; the lower edge of the ring portion is bevelled to suit all *Marks* of No. 80 fuzes without covers and is provided with a projection to fit the square notch in the flange of the fuze body. The upper edge

of the ring is provided with a slot to fit over the projection on the cover when screwing in No. 80 fuzes with cover.

The *Mark I* key differs from the *Mark II* in the upper edge not being prepared for use with fuzes with cover.

Implements, ammunition—Key, No. 18, setting Nos. 80 and 83 fuzes.—The *Mark I* key is for use when the lower time ring is too stiff to set by hand. It is made of steel and formed to engage with the pin projection of the lower time ring. It is provided with a loop of white line 30-inches in length.

The *Mark II* key differs from the *Mark I* in the ring portion being of greater depth, thereby taking a better seating on the fuze.

Total length of key 6·17-inches.

Implements, ammunition—Key, No. 27, primer 13 and 18-pr.—This key is for use in inserting or removing the percussion primer in the cartridge. It is made of steel and formed to engage with the two recesses in the head of the primer. It is also fitted with a white line lanyard.

Total length of key 13·1-inches.

„ „ lanyard 43 „

Implements, ammunition—Key, No. 32.—This key is alternative to the No. 17 *Mark II* key, to which it is similar except that it is double-handled and instead of the projection for fixing the earlier marks of fuzes being formed solid in the key, it is made separately of hardened steel wedge-shaped and driven into the key. It is heavier and stronger than the No. 17.

Implements, ammunition—Key, No. 53.—2-inch percussion fuzes. This key is for use in lieu of the No. 16 key, with 2-inch percussion fuzes and for “Adapter, 2-inch fuze hole No. 2.” Each end is semi-circular in shape with the inner end chamfered and a projection formed to engage in the slot for the purpose.

Implements, ammunition—Key, No. 59.—This key is for use in removing G.S. fuze hole plugs, also for G.S. special and 2-inch fuze hole plugs, except 2-inch No. 3 *Marks IV and V* and No. 8.

It is made of steel. It is double-handled, and consists of a 15-inch round bar passing through a centre portion, having a circular base recessed to fit over the plugs, a projecting rib being formed across the centre of the recess to engage in the key slots on the top of the plugs.

A slightly tapered square projection is formed on the top of the centre portion for use with plugs having square recesses.

Implements, ammunition—Key, No. 73.—Fixing T. & P. No. 80, Mark XI and Time No. 180, Marks X and XI fuzes with or without cover.—The key is double-handled and shaped at the centre to fit over the fuze; a square recess is cut in the ring portion to receive the stud on the fuze body.

Indicator, fuze, Mark III (Plate XX).—This indicator is of delta metal, graduated, with clamping handle and plate with two screws, reader with spring and tension screw and two stop screws; it is fitted with a reversible slide for Nos. 80 and 85 fuzes and a movable M.V. corrector scale.

The base plate is about 34½-inches long, graduated on the upper

portion with a yard scale, the lower portion being fitted with a movable M.V. corrector scale; it is grooved in the centre to receive the slide which is reversible and graduated with a fuze scale.

The corrector which is of brass is graduated on the upper edge with the fuze corrector and on the lower edge with two M.V. scales, one for carriages fitted with M.V. correcting gear and the other for carriages not so fitted; it is provided with a slot towards each end and is secured on the indicator by two cheesehead screws on which the corrector is able to slide. An index plate is provided and it is secured to the under side of the indicator.

The slide can be secured in any position desired by means of the clamp which is attached to the base plate. The yard and fuze scales are read by the reader, which is free to move along the base plate, but it is prevented from coming off the base plate by stops. Attached to the reader is a small spring which can be manipulated by a screw for taking up any play in the reader due to wear.

Key, removing jammed cartridge case.—This key is for use in removing cartridge cases which have jammed after firing. It consists of a steel rod, one end of which is formed into a key to fit the key-holes in the primer and the other end has screwed and riveted to it a metal plug of the same dimensions as the percussion primer, the bush being screw-threaded to fit the primer hole in the cartridge case. A cross handle is formed about the centre of the rod for hauling purposes.

Lanyard, firing, No. 15, Mark II.—The firing lanyard is of steel wire rope 10-feet in length with a steel hook on one end shaped to suit the trigger of Q.F. 18-pr. and 13-pr. guns. A steel toggle is attached to the other end of the lanyard.

The *Mark I* differs in being made of tarred white line and has a wooden toggle (see *Plate XXI*).

Pin, firing, dummy and Screw, breech, dummy.—The above-mentioned fittings are provided for drill and instructional purposes and are intended to prevent wear to the service mechanism and breech opening of gun.

The dummy firing pin differs from the service pin in not having the portion which projects through the firing hole bush.

The body of the original *Mark I* dummy breech screw is of wood, having front and rear bronze plates and a copper alloy ring with screw thread, which engages the screw threads in the breech opening of the gun. The rear plate is arranged to fit the carrier and is provided with bevel teeth corresponding with those on the breech mechanism lever. The interior of the breech screw is recessed for the reception of the service striker with firing pin removed and dummy firing pin substituted. The interior of the front plate is fitted with a rubber pad to take the blow of the dummy firing pin when the trigger is pulled; this pad, when worn out, will not be replaced.

Dummy breech screws of later manufacture have the outer face of the front bronze plate made similar in shape to the front end of the service breech screw, but slightly larger in diameter, so as to work the extractor in the gun. Such dummy breech screws are described as *Mark II*. Existing *Mark I* screws altered to conform to the *Mark II* pattern are known as *Mark I**.

In future manufacture dummy breech screws will differ from *Mark II* in being entirely of bronze, cast to shape and in having a vulcanized fibre pad in the front-end of the striker and dummy firing pin. Such dummy breech screws will be described as *Mark III*.

In the case of Q.F. 18-pr. guns using *Mark I* dummy breech screws, if the drill cartridge case is not used for loading on account of grit, &c., getting on the breech screw, the extractor should be removed from the gun.

Scale, range correction.—A *Mark II* range correction scale is issued for use with range dials graduated in yards for a M.V. of 1,615 f.s. and consists of an ivory body to which is pivoted a transparent celluloid plate. The scale is contained in a stiff cardboard box.

Scales representing map range, increase and decrease of range and air temperature are engraved on the body.

The map range is graduated in multiples of 500-yards from 0 to 8,000-yards, and figured at every 1,000-yards.

The increase and decrease of range scales are graduated in multiples of 25-yards from 0 to 500 and figured at every 100-yards.

The air temperature scale reads from 20 to 100-degrees. Fah. in multiples of 5-degrees.

Scales representing wind velocity and barometer readings are engraved on the celluloid plate.

The wind velocity scale is graduated in multiples of 10 and read from 0 to 50-feet per second with or against the wind.

The correction is for use with all charges, and from it can be calculated the correction required for any variation from the normal of conditions affecting external ballistics; the correction for any variation affecting internal ballistics must be calculated and applied separately.

To use the scale.—Ascertain the temperature and barometer readings. Set these readings to coincide on the scale. The amount of correction is then read off the ivory body by means of the wind scale curves.

Rimer, breech screw, Q.F. 13 and 18-pr.—The rimer is of steel and consists of a cutter with holder, sleeve and guide block. It is for use in removing burrs from the striker recess in the breech screw.

Setter, fuze, hand, Q.F. 18-pr., Mark I.—The setter, which is for use with No. 80 type of fuzes fitted with stud and slot, consists of a graduated ring with setting ring, screwed on to a locking ring with steadying legs and a graduated plate. The graduated ring has vertical graduations round the edge to correspond with those on the fuze, filled in with white wax and has a safety mark filled in with red wax. Two handles are formed on the side and holes are tapped on the top to receive the screws for securing the graduated plate, also a hole to receive a screw with finger piece for the locking device, on either side of which are two pins to limit its travel.

The locking ring is screwed into the underside of the graduated ring and has three steadying legs with adjusting screws, one of the legs being fitted with a spring plunger to engage in the slot in the flange of the fuze.

The setting ring, which is secured between the graduated ring and the locking ring, is shaped internally to the contour of the fuze time rings, and has a slot cut in the bottom inner edge to receive the stud

on the setting ring of the fuze; a brass indicator is screwed on the top face.

The graduated plate is secured by three screws in a recess in the top of the graduated ring and has graduations on one side corresponding to those on the fuze, a safety mark and the following words:—

“To be used with or without calibrating sights.”

The safety mark is filled in with red wax and the other markings with white wax.

Earlier issues of the fuze setter had three plates which were marked with the muzzle velocity for which graduated, but the one now fitted is graduated for normal muzzle velocity (M.V. 1,615 f.s.) and is not marked.

Instructions for use.

The amount of setting is determined by the angle which exists between the slot in the setting ring and the spring plunger in the steadying leg of the locking ring.

To adjust this angle the “setting” ring is turned until the pointer (or indicator) is in exact register with the required fuze setting shown on the graduated plate and is clamped in position by a pressure of the finger-piece of the locking device.

The setter is then placed over the fuze and rotated until the slot in the base of the setting ring engages the stud on the time ring of the fuze, after which the rotary movement is continued, in either direction, until the spring plunger in the steadying leg engages in the slot in the flange of the fuze and prevents further movement. The fuze is then set.

“Care should be taken that during the rotary movement an even downward pressure is placed on the setter to prevent the slot in the setting ring disengaging from the stud on the fuze.”

NOTE.—The marking on the outside of the fuze setter is placed there to enable a reading to be obtained at any time of the actual setting given to the fuze by the fuze setter.

The *Mark II* fuze setter differs from *Mark I* in not being fitted with a separate graduated plate, the scale being engraved on the top surface of the graduated ring and vertical graduations round the side omitted.

The pointer (or indicator) on the setting ring is engraved instead of being made in metal and screwed on.

Tools, packing gland, Q.F. 18-pr.—Collar, Mark I, Plug, Mark I.—The collar and plug are for use in packing the stuffing-box of the hydraulic buffer.

The collar is for assisting the compressed (“Dicks”) packing ring over the shoulder of the piston rod.

The plug is for removing the packing and supporting rings and packing washers from the stuffing-box.

Tool, withdrawing ring supporting packing, Q.F. 13 and 18-pr., Mark I.—The tools are for withdrawing the outer ring supporting packing from the stuffing-box of the hydraulic buffer.

Wrench, breech mechanism, No. 77.—The wrench is of steel and is for use in removing or inserting the firing hole bush in the breech screw.

PART VII.
AMMUNITION.

PROJECTILES.					FUZES.	CARTRIDGES.			Means of firing.
Nature.	Mark. (a)	Bursting Charge.		Approximate weight filled and fuzed.		Nature of Charge.	Weight of Charge.	Approximate weight for empty cartridge case with primer and clip.	
		Nature.	Weight.						
High Explosive (stream-line)	I.C.	H.E.	lb. oz. dr. 1 1 4	lb. oz. dr. 18 8 0	D.A. No. 115E or 115 ...	Cordite M.D. or R.D.B., size 8 (full charge)	lb. oz. dr. 1 6 4	3 9 8	Primer percussion Q.F. cartridges, No. 1.
High Explosive	VII	H.E.	0 15 4	18 8 0	D.A. No. 106E or 106 or P. No. 101E with No. 2 gaine	Cordite M.D. or R.D.B., size 8 (full charge)	1 6 15		
High Explosive	VII	H.E.	0 15 4	18 8 0	D.A. No. 106E or 106 or P. No. 101E with No. 2 gaine	Cordite, size 7½ (full charge for India)	1 4 0		
High Explosive	VII	H.E.	0 15 4	—	D.A. No. 106E or 106 ...	Cordite M.D. or R.D.B., size 2¼ (reduced charge)	0 9 0		
Shrapnel...	XVII	Powder	0 1 12	18 8 0	T. & P. No. 80 ...	Cordite M.D. or R.D.B., size 8 (full charge)	1 6 15		
Shrapnel...	XVII	Powder	0 1 12	18 8 0	T & P. No. 80 ...	Cordite, size 7½ (full charge for India)	1 4 0		

Shrapnel...	XVII	Powder	0 1 12	18 8 0	T. & P. No. 80 ...	Cordite, M.D. or R.D.B., size 2½ (reduced charge)	0 9 0	} 3 9 8	Primer percussion Q.F. cartridges, No. 1
Gas ...	VI	—	—	18 8 13	D.A. No. 106E or 106 ...	Cordite, M.D. or R.D.B. size 8 (full charge)	1 6 15		
Gas ...	VI	—	—	18 8 13	D.A. No. 106E or 106 ...	Cordite, size 7½ (full charge for India)	1 4 0		
Smoke ...	II	—	—	18 9 2	D.A. No. 106E or 106 or P. No. 101E with No. 2 gaine	Cordite M.D. or R.D.B., size 8 (full charge)	1 6 15		
Star (b) ...	IV	Powder	0 0 2	16 0 11	Time No. 180 ...	Cordite M.D. or R.D.B., size 8	1 1 10		
Star (b) ...	III	Powder	0 0 3½	10 13 8	Time No. 25 ...	Cordite, size 5 (charge for India)	0 7 4		
—	—	—	—	—	—	Blank, L.G. ...	1 0 0		
—	—	—	—	—	—	Cordite M.D.T. or R.D.B.T., size 15/13	0 8 12		

(a) Other Marks may be met.

(b) Star shell and No. 25 time fuze are now obsolete.

NOTE.—Only No. 106E fuzes may be used at present for practice with H.E., *vide* A.C.I. 52 of 1920.

CARTRIDGE, Q.F. 18-PR., SHRAPNEL.

*(Typical for Full Charges.)**(Plate XXII.)*

The ammunition is fixed, and a complete round consists of a cartridge case, percussion primer, charge, shrapnel shell and fuze.

The case is made of solid drawn brass, slightly tapered towards the mouth, and has a hole in the base screwed and recessed to take a percussion primer; a rim is provided by means of which the extractor of the breech mechanism automatically ejects the empty case when the breech is opened.

The No. 1 percussion primer consists of a metal body screwed externally for a portion of its length to fit the primer hole in the cartridge case and contains a percussion cap and powder magazine. (Plate XXIII.)

The charge consists of a 1-lb. $6\frac{1}{3}$ -oz. bundle of cordite M.D. or R.D.B., size 8 recessed at one end to fit over the primer and the boss of the case, the other end being in contact with the shell. The cordite sticks are secured in two places by shalloon braid.

The charge for India consists of 1-lb. 4-oz. of cordite, size 7 $\frac{1}{2}$, and differs from the above in the cordite being secured in three places instead of two by shalloon braid.

The shrapnel shell has a steel body with a recess in the base to contain a tin cup for the bursting charge. The head of the shell is struck with a radius of two diameters and is fitted with a 2-inch metal fuze socket.

A brass tube conveys the flash of the fuze to the bursting charge, one end of the tube being fitted into a fuze socket, the other being screwed into a steel disc placed over the tin cup.

The Mark XVII shell contains approximately 292-mixed metal bullets (41 per lb.) and is fitted with a copper driving band in a groove having two waved ribs. The number of bullets varies with the Mark of the shell.

The shell is secured in the case by the edge of the latter being pressed into the groove at the rear of the driving band.

The base of the cartridge case is unpainted.

CARTRIDGE, Q.F. 18-PR., SHRAPNEL.

*(Typical for Reduced Charges.)**(Plate XXIV.)*

This cartridge is generally similar to the full charge; the reduced charge is 9-oz. of cordite M.D. or R.D.B., size 2 $\frac{1}{4}$. It consists of a cylindrical bundle of cordite sticks tied in seven places with double silk sewing, with two fins of cordite passed through the centre of the charge at right-angles to it near each end, to keep the charge central in the case.

A recess is formed in the base of the charge to fit over the boss in the bottom of the case and the plain portion of the percussion primer.

To distinguish shrapnel cartridges with reduced charges the shell from the shoulder to the driving band and the base of the cartridge case are painted white.

As an alternative method of making up the charge the fins are omitted and a small ring of cordite sticks placed around the base of the charge.

CARTRIDGE, Q.F. 18-PR., H.E.

(*Typical for Full Charges.*)

(*Plate XXV.*)

This cartridge consists of a case with primer, charge, H.E. shell and fuze.

The case and primer are the same as described for the shrapnel cartridge.

The charge consists of 1-lb. $6\frac{1}{8}$ -oz. cordite M.D. or R.D.B., size 8, as described for the shrapnel cartridge.

The charge for India consists of 1-lb. 4-oz. of cordite, size $7\frac{3}{4}$, and is similar to that described with shrapnel.

The H.E. shell consists of a forged steel body, the head of which is screwed internally to the 2-in. fuze-hole gauge for a depth of 1.2-ins.

Near the base of the shell a groove is turned, in which is fitted a copper driving band.

The shell is secured in the cartridge case by the edge of the latter being pressed into the groove of the driving band.

The base of the cartridge case is painted yellow.

CARTRIDGE, Q.F. 18-PR., H.E.

(*Typical for Reduced Charges.*)

(*Plate XXVI.*)

The M.D. and R.D.B. reduced charges of 9-oz., size $2\frac{1}{2}$, each consist of a cylindrical core of 10.4-in. cordite sticks secured in two places with silk sewing surrounded at the base by a ring of 4.1-in. sticks, tied in two places with silk sewing and so arranged as to fit over the boss of the case and protruding portion of the primer. The base of the cartridge is painted yellow with a white band across the centre. The shell is painted white from shoulder to driving band.

CARTRIDGE, Q.F. 18-PR., H.E. STREAMLINE.

The *Mark I* cartridge consists of a case with primer, a charge of cordite M.D. or R.D.B. shell and fuze.

The case and primer are the same as described for shrapnel.

The 1-lb. $6\frac{1}{8}$ -oz. charge of cordite M.D. or R.D.B. consists of a cylindrical core of 8.4-inch cordite sticks tied in two places with silk or cotton sewing, surrounded by a ring of 9.1-inch sticks secured in three places by shalloon braid or white tape and so arranged that a recess is formed at the base to fit over the boss of the case and the protruding portion of the primer.

The *Mark I.C.* streamline shell is made of forged steel with an 8-calibre radiused head and a parallel cavity.

The head of the shell proper is screwed internally to the 2-inch fuze-hole gauge, or alternatively, when shell have been manufactured light to weight or with defective fuze holes, the top of the shell wall is cut down, recessed and screwed externally and fitted with a separate screwed-on head which is screwed internally to the 2-in. fuze-hole gauge.

The body of the shell is tapered off below the driving band to the base at an angle of $7^{\circ} 30'$ and a steel plate disc is screwed or riveted into a recess in the base. The driving band is similar to that of the other 18-pr. shell.

The base of the cartridge case is painted with a $\frac{1}{2}$ -inch white outer ring, the remainder being yellow.

CARTRIDGE, Q.F. 18-PR., CORDITE, M.D. OR R.D.B., STAR SHELL.*
(Plate XXVII.)

The case and primer are the same as described for the shrapnel cartridge.

The charge, which consists of 1-lb. 1-oz. 10-drs. cordite M.D. or R.D.B., size 8, extends from the primer to the base of the shell and is secured in three places with shalloon braid.

The *Mark IV* shell is of the parachute type and has a removable base held by one steel twisting pin and three copper shearing pins. A lead washer is fitted between the base and the shell. The head is struck to a radius of 2-calibres and is screwed to the 2-inch fuze-hole gauge.

The shell has a bursting charge of 2-drs. R.F.G.² powder and is fitted with a copper driving band.

The base of the case is painted white leaving the brass showing in the form of a star.

CARTRIDGE, Q.F. 18-PR., CORDITE, SIZE 5, STAR SHELL.*
(Plate XXVIII.)

The case and primer are the same as described for the shrapnel cartridge.

The charge of 7-oz. 4-drs., size 5 cordite, consists of a cylindrical core of 3.75-inch cordite sticks tied in two places with No. 1 doubled silk sewing or No. 14/6 cotton sewing, surrounded by a ring of 4.25-inch cordite sticks secured in two places with 0.35-inch shalloon braid or 0.5-inch white tape, and is arranged to fit over the boss of the cartridge case and the protruding portion of the primer. A paper cylinder is placed between the top of the charge and the base of the shell to prevent movement of the charge.

Mark III, Star Shell.—The body is made of steel and recessed in the base to receive a bursting charge of $3\frac{1}{2}$ -drs. R.F.G.² powder contained in a shalloon bag and threaded with a quick-match. The head is fitted with a G.S. fuze hole socket and wooden block and is attached

* Star shell are now obsolete.

to the body with brass screws and steel twisting pins. A metal central tube perforated with 12 fire holes is screwed into a wrought iron diaphragm over the bursting charge, the other end fitting into the fuze sockets.

The interior of the shell is velvilled and lined with brown paper, and contains 10 stars in two tiers of 5; a perforated iron disc separates the tiers and is supported by wood supports which are placed between the stars in each tier. The faces of the disc are covered with felt washers, and a felt washer is placed between the top of the stars and the wood block in the head.

A copper driving band is fitted round the shell near the base, having two waved ribs.

CARTRIDGE, Q.F. 18-PR., CORDITE, M.D. OR R.D.B., GAS SHELL.

The *case and primer* are the same as described for the shrapnel cartridge.

The *charge* consists of 1-lb. 6-oz. 15-drs., size 8, M.D. or R.D.B. cordite.

The *charge for India* consists of 1-lb. 4-oz. of cordite, size 7 $\frac{3}{4}$, and is similar to that described with shrapnel.

The *base* of the cartridge is painted light grey for identification purposes.

The *shell* is made of steel, iron or semi-steel, with a 2-calibre radius head. It has a parallel cavity tapered off near the bottom and the head is screwed internally to receive a combined fuze socket and burster container; a tapered filling hole is provided below the shoulder of the shell.

The *burster container* is about 2.53-inches deep and has a tapered flange at the top, below which it is screwed to suit the shell. The mouth is screwed to the 2-inch fuze-hole gauge to receive the No. 106 fuze.

A *copper driving band* similar to other 18-pr. shell is provided and a steel plate disc is screwed or riveted into the base of the shell, except in the case of *Marks II and V* shell, the bases of which are solid.

The *shell* is painted grey with a coloured band round the body denoting the type of gas with which filled.

CARTRIDGE, Q.F. 18-PR., CORDITE, M.D. OR R.D.B., SMOKE SHELL.

(Plate XXIX.)

The *case primer and charge* are the same as for the shrapnel shell.

The *base* of the cartridge is painted green for identification purposes.

The *shell* is made of forged steel with a 2-calibre radius head and a parallel cavity.

The head of the shell proper is screwed internally to the 2-inch fuze-hole gauge to receive the fuze and a steel shell exploder container and is provided with a fixing screw for securing the fuze.

A steel base plate is screwed or riveted into a recess in the base and a copper driving band is fitted into an undercut groove the bottom of which is either knurled or has two waved ribs formed to prevent the band from turning on the shell.

The smoke composition is contained in a tinned plate container which is "U" shape in section, the exterior being shaped to fit the shell cavity and the interior to receive the tube of the exploder container.

The shell is painted light green for identification purposes.

CARTRIDGE, Q.F., BLANK, 18-PR., FILLED, 1-LB. BLANK, L.G.

The *Mark II* blank cartridge consists of a service case and percussion primer, with a charge of 1-lb. blank L.G. contained in a No. 1 class silk cloth bag having three silk braid hoops, which together with a felt disc with lifting loop is enclosed in a felt jacket.

The mouth of the cartridge is closed with a millboard wad, split paper ring and leatherboard cup.

CARTRIDGE, Q.F., BLANK, 18-PR., FILLED, 8-OZ. 12-DRS. CORDITE M.D.T. OR R.D.B.T., SIZE 15-13, MARK I.

This blank cartridge consists of a service case and percussion primer, with a charge of 8-oz. 12-drs. cordite M.D.T. or R.D.B.T., size 15-13.

The charges consist of a circular bundle of cordite, tied in three places with "silk, sewing, No. 1," and having a recess at one end to take the end of the percussion primer in the base of the cartridge.

The igniter consists of two circular shalloon discs stitched together to form a circular pocket in the centre and an outer ring, the latter being stitched across to form four pockets. The pockets are filled with 6-drs. of R.F.G.² powder, 2-drs. in the centre one and 1-dr. in each of the pockets of the ring.

The igniter is placed over the end of the charges and tied to the first tie of the bundle in four places, the centre pocket being placed at the bottom of the recess in the cordite and the outer ring over the ends of the outside sticks of cordite.

The charges are held in position in the cartridges with a millboard disc, split paper ring and leatherboard cup.

The *Mark II* M.D.T. cartridge differs chiefly from the above in having no recess at the base of the charge to receive the percussion primer.

The empty cases for making up blank locally are issued 20 in a "Box, cartridge cases, Q.F. 18-pr."

Instructions for making up blank and smokeless blank cartridges with charges issued for the purpose, as may be necessary from time to time, will be found on the lid of the box in which the empty cases are received.

CARTRIDGE, DUMMY, Q.F. 18-PR.

The *Mark II* dummy cartridge is for use in practising fuze setting. It consists of an empty service shell body secured in a service case in the usual manner and further secured by a bolt, one end of which is fitted into the primer hole of the cartridge and the other end screwed into the base of the shell.

The shell is fitted with a 2-inch fuze-hole socket closed at the bottom, and is filled with a mixture of dust and lead ash.

The cartridge case contains a wood block which is recessed at one end to fit over the boss in the base. Four holes are bored in the side and three in the base of the case, for ready identification of the dummy cartridge.

CARTRIDGE, DRILL, Q.F. 18-PR., MARK V.

The cartridge is made of wood shaped to represent the service shell and cartridge case. It is fitted with a brass base and metal nose, which are connected by a screwed mild steel bolt, the end screwed into the brass base of the cartridge having a recess with a rubber plug for the gun striker to impinge against. The metal nose is threaded to the 2-inch fuze-hole gauge and provided with a fixing screw.

The *Mark VI* drill cartridge differs from the above in having a slightly different shaped fuze-hole socket.

FUZES.

Instructions Relating to the Care of No. 106, 106e, 115 and 115e Fuzes.

(1) *The wire seal is broken and the safety cap of the No. 106, 106e, 115 and 115e fuzes removed only immediately prior to loading.*

(2) *If a No. 106, 106e, 115 and 115e fuze has become uncapped in any manner except that referred to in (1) or has the wire seal inadvertently broken, it is to be regarded as unfit for firing and is to be withdrawn from use.*

(3) *Fuzes withdrawn under paragraph (2) are to be examined to ascertain if the brass tape under the hammer head is present and correct; if this is so, the (safety) cap should be replaced and secured in position by a becket, and the fuze returned to the Ordnance Store for transmission to Woolwich. If examination shows that the brass tape is incorrect, or missing, the fuze may be in a dangerous condition and must be destroyed under expert supervision.*

In securing the (safety) cap with the becket, difficulty may arise with fuzes where the body is not provided with an eye through which the becket may be threaded; in such cases wooden pegs should be driven in the fixing key holes in the body and the becket fastened round these.

(4) *It is essential that the becket should be fastened in such a manner so as to prevent the cap coming off in transit to Woolwich. The method of fastening the fuze cap is as shown on Plate XXXVII.*

FUZE, TIME, 15-SECONDS, No. 25, MARK V.*

(Plate XXX.)

The fuze consists of the following principal parts, viz., body, cap, ring, needle plug with steel needle, detonator pellet with detonator, safety pin, stirrup spring and leather washer.

The *body* is made of brass, the lower part being threaded to the G.S. gauge. Above the threaded portion it is enlarged, forming a shoulder under which is placed a leather washer. The top part of the body is reduced in diameter, forming a stem, and is screwed externally to

* Fuze, time, No. 25, is now obsolete.

receive the cap. The stem is bored out, forming a lighting chamber in the bottom of which is screwed the needle plug having the steel needle on its upper face. Three flash holes are bored through the stem communicating from the lighting chamber into an annular groove cut round the exterior of the bottom of the stem. One of these holes is primed with a small pellet of gunpowder.

The flange of the body is graduated from 0 to 44 and the graduations read to the right. The setting mark is on the composition ring.

On the underside of the ring a flange is formed which fits into a groove cut in the face of the body round the bottom of the stem.

The composition channel is filled with fuze composition and then covered with a washer of vegetable paper. At the beginning of the fuze composition there is a gas escape hole closed by a brass disc, waterproofed. Another hole is bored through to the inner circumference of the ring to allow the flash from the hole in the stem to ignite the composition in the ring.

A cloth washer is shellaced to the top of the fuze body, on which rests the ring.

The *detonator pellet* is supported in the top of the lighting chamber by means of a brass stirrup spring, the upper arms of which rest on two slots cut away on the top of the stem. This pellet is bored out and contains a small detonator which is retained in position by means of a screwed plug.

A brass washer fits over the stem on top of the ring, which is clamped by means of a cap screwed on the top of the stem and secured by a set screw.

The detonator pellet is secured in a safe position until the moment of loading by means of a phosphor bronze safety pin, which passes through the cap and detonator pellet.

The lower portion of the body is recessed and filled with loose grain powder, forming a magazine which is closed by a brass plug with brass washers and linen disc.

The ring is connected to the magazine by means of an oblique channel filled with loose powder.

Action.—The fuze is set by means of Key No. 13 by turning round the ring until the setting marking is opposite the graduation ordered. At the moment of loading the safety pin is withdrawn.

On the shock of discharge the pellet sets back, straightening the arms of the stirrup spring, and carries its detonator on to the point of the needle. The flash from the exploding detonator passes through the holes in the stem and round the groove to the powder pellet at the commencement of the composition. The ring burns round until it comes to the pellet of powder in the body which fires the magazine of the fuze and bursting charge of the shell.

Time of burning at rest 15 seconds.

FUZE, TIME AND PERCUSSION, No. 80.

(Typical.)

(Plate XXXI.)

The fuze is made of aluminium, brass or steel according to the pattern of the fuze and consists of the following principal parts, viz.,

body with ring, upper and lower composition rings, two cloth washers, cap with set screw, base plug, time and percussion arrangements.

The lower part of the body is arranged to provide a holder for the percussion arrangement, and the upper portion forms a short stem containing the time detonator pellet and its stirrup spring, the holder being either a separate fitting or a part of the body, according to the design of fuze. With aluminium fuzes the shoulder or flange of the body is fitted with a ring, to the lower part of which the fuze cover is secured. The upper part of the ring is graduated from 0 to 22, each graduation being divided into 10 parts; a square notch is cut for the "Key, No. 17 or 32," for fixing purposes and a small cross to denote the safety point. The *Mark XI* fuze is provided with a stud in the place of the square notch and requires the No. 73 key for fixing purposes. The lower part of the ring fits over the nose of the shell, and a leather washer, soaked in mineral jelly, is provided to make a tight joint between fuze and shell. The fuze is screwed externally to the 2-inch gauge.

A pin is screwed into the lower time ring to form a projection, by means of which the ring is set with the "Key, No. 18." A setting mark is cut on the ring.

The upper time ring is prevented from turning by two pins, which secure it to stem.

The cap is screwed on to the body over the upper time ring at a certain definite tension. It is secured in position by a set screw.

The base plug is screwed externally to fit the bottom of the body.

The holder for percussion arrangement carries the needles for both the time and percussion detonator. It is bored to receive the percussion detonator pellet, ferrule, stirrup spring and spiral spring.

All the external joints are waterproofed and a brass cover is provided.

To remove the cover from the fuze, tear off the strip securing ring, then remove the tearing-off strip, when the cap will fall off leaving the fuze exposed.

The fuze when set full should burn, at rest, for about 22-seconds.

To set the fuze, turn the setting mark on the lower ring opposite the graduation required, by means of the "Key, No. 18."

Action of fuze—Time arrangement.—On shock of discharge, the time detonator pellet sets back on to the needle, straightening the clips of the time stirrup spring, firing the detonating composition and so igniting the composition of the upper ring, which in succession lights that in the lower ring and so fires the magazine.

Percussion arrangement.—On shock of discharge, the ferrule sets back over the detonator pellet, straightening the clips of the percussion stirrup spring; the whole is then free to move forward on impact or graze, and after compressing the spiral spring, the detonator strikes the needle which ignites the composition, and so fires the magazine if the time arrangement has not functioned.

The fuzes are packed one in a "Cylinder, No. 80r."

FUZE, TIME AND PERCUSSION, No. 80b.

The fuze is generally similar to the No. 80 but the lip of the flange is removed.

FUZE, TIME, No. 180.

(Plate XXXII.)

These *fuzes* are similar to the No. 80 fuze, from which they differ in having the percussion arrangement removed, the holder being plugged with a hardwood plug. They have a large "T" painted in blue on the side.

FUZE, TIME, No. 180B.

These *fuzes* are similar to No. 180 fuzes, but have no lip to the flange.

FUZE, PERCUSSION, No. 101E.

(Plate XXXIII.)

The *fuze* consists of the following principal parts :—

Body, cap with needle, graze pellet, detonator, plug, creep spring, centrifugal bolt, detent, detent spring, safety shutter and adapter.

The *body* is screw-threaded externally at its lower end to the 2-inch fuze-hole gauge, while its upper end is conical in shape and fitted with a rounded cap. Below the cap the body is bored out to receive the graze pellet and below this again a fire channel leads to the safety shutter. A second opening, of two diameters, is bored in the body parallel to the fire channel for the reception of the detent and its spring; after assembly and inspection of the empty fuze this opening is closed at the top by a brass or copper ball. Near the upper end of the opening of the larger diameter and through that of the smaller diameter, a hole is bored at right angles for the centrifugal bolt. Around the outside of the body is a knurled ring, black band or groove to denote that the fuze is not fitted with a cocked pellet, and slots are provided to receive the No. 53 key for fixing purposes. A groove is formed round the lower end of the body for the purpose of punch stabbing the fuze into the shell. The lower end of the body is bored out and screwed to receive an adapter.

The *cap*, which is screwed into the upper end of the body, has a steel needle screwed in from the top.

The *graze pellet* is hollow and is screwed internally at its lower end for the plug. Its upper end is stepped to form seatings for the centrifugal bolt and creep spring. The space between the bottom of the pellet and the top of the shutter is filled by a paper cylinder.

The *plug*, which is screwed into the graze pellet from the underside, has a central fire channel bored through it. It forms a support for the detonator.

The *detonator* consists of a copper cup containing 1.7-grains of detonating composition; the top of the composition is covered by a brass disc and copper washer and its underside by a brass disc, the whole being held in the cup by the top edge of the latter being spun over. It fits inside the graze pellet, in which it is held by the plug.

The *creep spring* is interposed between the upper end of the graze pellet and the underside of the cap.

The *centrifugal bolt* is fitted into an opening at the upper end of the body, the opening being closed by a screw plug. The bolt is kept in

position by the stem of the detent which passes up behind it. Its inner end fits over a shoulder on the upper end of the graze pellet.

The *detent* consists of a body with pin connected by a ball and socket joint; the stem of the latter passes up through a hole in the top of the fuze and behind the centrifugal bolt, and is kept in position by a spiral spring, which bears against the underside of the body and is held in position by a plug screwed into the body of the fuze.

The *safety shutter* is housed in a circular recess on top of the gaine adapter. It comprises a metal disc, shutter, detent, spring and tin cap.

The disc is circular and is bored axially to provide a fire channel, whilst a transverse slot is cut across its upper surface to receive the shutter, detent and spring. The shutter is rectangular in section, and slides freely in the slot of the disc, but normally masking the fire channel; one end is slotted and bored to receive the detent stem, the other end being plain. The detent, of ball and stem in one, rests in the disc with the stem entered in the shutter recess, centering the C.G. of shutter to the spring side of the fuze axis. The spiral spring retains the shutter in the closed position and lies between shutter and tin cap. The tin cap has a central fire channel and fits over the disc, retaining the shutter devices in the assembled position.

The shutter opens when spun at revolutions from 2,000 to 3,000 per minute.

The *adapter* is screwed externally at its upper end to screw into the bottom of the fuze, in which it is held by a set screw and internally for the greater part of its length to receive the gaine, which, in turn, is held by a set screw. The upper end of the central opening is plain and enlarged to form a chamber for the reception of the safety shutter.
NO PREPARATION FOR ACTION IS NEEDED.

Action.—On firing, the detent behind the centrifugal bolt sets back, compressing its spring. When the stem of the pin is clear of the fuze body, centrifugal force carries the stem over, and the spring re-asserting itself jams it under the shoulder of the recess. This leaves the centrifugal bolt free, and the rotation of the shell causes the bolt to move outwards and so unlocks the graze pellet. Whilst the shell is under acceleration in the bore the friction caused by the set-back of the shutter will probably prevent the latter opening. After the shell has left the bore the shutter is moved outwards by centrifugal force compressing the spring. In moving outwards it releases the detent. The detent stem being unsupported moves out of centre and engages a shoulder in the shutter and so keeps the shutter clear of the fire holes in cap and disc. During flight the graze pellet is prevented from moving forward by the creep spring, but on graze or impact it moves forward, carrying the detonator on to the needle. The flash from the detonator passes down through the fire channels to the gaine, which in turn detonates the bursting charge in the shell.

Packed one in a tin cylinder, No. 101F.

GAINES No. 2.

The *gaine* which forms the magazine of the Nos. 101E and 101F is of steel, screw-threaded externally at each end to fit the

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adaptor and take the closing cap respectively. Internally it is bored from each end to form two compartments separated by a diaphragm which is pierced by a fire channel.

The upper and smaller compartment is filled with gunpowder in the form of perforated pellets, on the top of which may be placed a solid layer of gunpowder to provide a delay action.

The lower compartment contains pressed C.E. and a 10-grain fulminate detonator. A charge of 4.5 grains of gunpowder is placed on top of the fulminate. The bottom cap closes the gaine.

When provided with delay the gaine has a blue band and the fuze cap is painted blue.

Action.—The flash from the fuze detonator ignites the powder in the upper compartment and so strengthened passes through the fire channel to ignite the powder in the detonator. The fulminate detonates the C.E.

If fitted with delay powder, the latter would burn through before passing on to the detonator, so introducing a pause between graze of shell and detonation of gaine.

FUZE, PERCUSSION, D.A., No. 106E.

(Plate XXXIV.)

The *Mark IV* fuze consists of the following principal parts : body, safety cap, hammer, steel collar in halves, copper tape with weight, steel and dermatine washers, copper shearing wire, steel guide pin, detonator holder, detonator, magazine with shutter, shutter spring, bottom screwed cap, shalloon and paper discs.

The *body*, which is made of metal, is screw-threaded externally at its lower end to suit the 2-inch fuze-hole gauge. Its upper end, which is generally conical in shape, terminates in a cylindrical stem, which is screw-threaded to receive the cap. Slots are cut in the body to receive the No. 53 key for fixing purposes. The body is further prepared to receive a shearing wire, guide pin and a countersunk hole to take the wire securing the cap. A groove is cut round the shoulder for punch stabbing the fuze into the shell when fuzing the latter.

Internally the body is bored out in different diameters to receive the hammer, detonator holder and magazine.

The *hammer* is of steel, fitted with an aluminium head. The lower end is pointed to form a needle. Just below the head a recess is bored to take a stud on one-half of the steel collar, and in one side a slot is cut through which fits the shearing wire and guide pin. The hammer is placed in position from the top of the fuze body passing through a steel washer on the top of the latter. The guide pin is screwed into the body, one end entering the slot in the hammer. The shearing wire passes through the body and hammer, the ends being afterwards turned over. The function of the guide pin is to prevent the hammer turning whilst the tape is being unwound, while the shearing wire keeps the hammer clear of the detonator after the collar has become detached. Around the hammer, under the head and resting on the steel washer of the body, is a steel collar in

halves, one-half of which has a pin to fit the recess in the hammer, and around this again is wound a copper tape to the outer end of which is soldered a weight. The top of the fuze is then closed by a U-shaped steel or malleable cast-iron cap which screws on to the projection at the top of the body against a dermatine washer and is held in position by a steel wire which passes through an eye in the cap, the two ends being twisted; a complete turn is then taken round the cap and the loose ends inserted in the hole provided in the body and fixed therein by a lead plug pressed in.

The *detonator holder* is held in position by the top surface of the magazine. Its upper end is recessed to receive the detonator; which is held in position by the mouth of the holder being spun over. A cupro-nickel or brass disc is placed on top of the detonator. An opening in two diameters is bored through the centre of the holder below the detonator, which is filled with loose C.E., the opening being closed by a paper disc shellaced to the bottom of the holder.

The *magazine* is screwed externally to suit the interior of the body and is reduced in diameter near the bottom and screwed to receive the bottom cap. The top of the magazine is recessed to receive a shutter and spring. The magazine is bored internally in two diameters to within 0.003-inch of the shutter recess; the smaller bore is filled with loose C.E. whilst the larger bore takes a compressed pellet of C.E. A paper disc separates the loose C.E. from the pellet.

The shutter is of metal, shaped and pivoted to admit of movement when acted centrifugally. It is interposed between detonator holder and magazine, and in the closed position is designed to prevent the detonator functioning the magazine. It is pivoted at one end by an axis pin and is retained in the closed position by a coiled spring sufficiently strong to prevent movement until a rotation of 1,300 to 1,700 revolutions per minute is attained. A hole is bored through that portion of the shutter which is in the central position when shutter opens; this is filled with loose C.E.

A *set screw* is screwed into a hole in the body of the fuze and holds the magazine in position.

Preparation of fuze.—To prepare the fuze the wire is broken, and the cap unscrewed and removed at the moment of loading.

Action.—After leaving the bore the rotation of the shell causes the weight on the tape to fly outwards and the latter to become unwound from the steel collar; the halves of the steel collar in turn drop off, leaving the hammer supported only by the shearing wire.

The rotation of the shell causes the shutter to swing outwards until the hole formed in it comes into line with the central perforation in the detonator holder and magazine. On impact the hammer is driven in, breaking the shearing wire and piercing the detonator; the consequent detonation passes through the loose C.E. in the detonator holder, shutter and magazine, to the C.E. pellet in the magazine, which, in turn, detonates the H.E. charge of the shell.

The *Mark IV S* fuze differs from the *Mark IV*, in the head of the hammer being made of steel instead of aluminium.

These fuzes are packed one in a tin cylinder, No. 101F, with exploder.

FUZE, PERCUSSION, D.A., No. 106.

This fuze differs principally from No. 106E in not being fitted with a safety shutter.

FUZE, PERCUSSION, D.A., No. 115.

(Plate XXXVI.)

This fuze is made of metal or steel and is generally similar in design to the later marks of the 106, the following being the principal points of difference.

The *body* is longer and differs slightly in external contour to agree with the 6 c.r.h. shell with which it is used, the coned portion having a longer taper. The space forming the magazine is correspondingly longer and receives a larger C.E. pellet.

FUZE, PERCUSSION, D.A., No. 115E.

(Plate XXXV.)

This fuze differs from the No. 115 principally in having a safety shutter of similar design to No. 106E.

By Command of the Army Council,



THE WAR OFFICE,
December, 1921.

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